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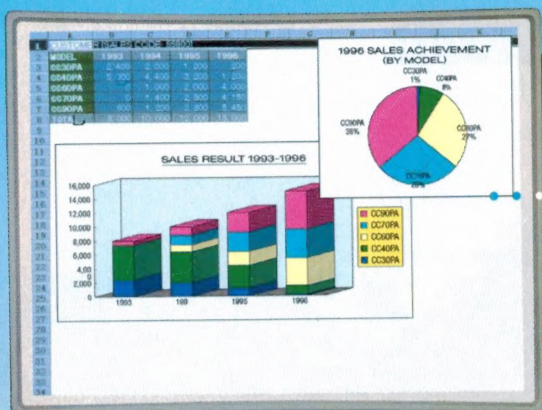
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LPF-3200 Liquid Crystal Projector



# Electronics

Volume 59, No.4  
April 1997

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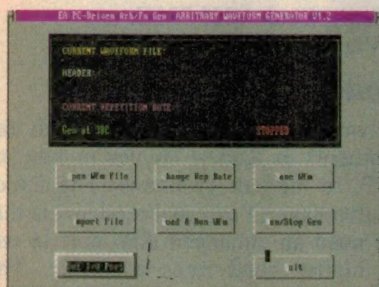
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## Video phones at last?



Among the new products on display at the recent Consumer Electronics Show in Las Vegas were a new crop of video phones, taking advantage of digital video compression. Could this be the year that video phones finally take off, after so many false starts? See our CES report from Paul Swart, starting on page 20.

## Software for the arb gen



To get you off to a good start with our PC-Driven Function & Arbitrary Waveform Generator, we've produced a couple of easy-to-use 'virtual instrument' programs — with another one to come, so you can design your own custom waveforms. The article discussing them starts on page 70.

## On the cover

As far as we know, Samsung was the first to demonstrate a sample DVD video player in Australia — and our reviewer Louis Challis was the first to put it through its paces. His report starts on page 10. Jim Rowe also reviews Brother's new ultra-low cost notebook, starting on page 24. (Photos by Kevin Ling, Ben Duncan.)

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**ELECTRONICS AUSTRALIA** is published by Federal Publishing Company, a division of Eastern Suburbs Newspapers Partnership, which is owned by General Newspapers Pty Ltd.

**A.C.N.000 117 322.**

Double Bay Newspapers Pty Ltd.

**A.C.N.000 237 598.** and

Brehmer Fairfax Pty Ltd.

**A.C.N.008 629 767.**

180 Bourke Road, Alexandria, NSW 2015.

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Printed by Macquarie Print, 51 - 59 Wheelers Lane, Dubbo 2830. Phone (068) 843 444.

Distributed by Newsagents Direct Distribution Pty Ltd, 150 Bourke Rd, Alexandria 2015; phone (02) 9353 9911.

**ISSN 1036-0212**

\* Recommended & maximum Australian retail price.

Member of the Audit Bureau of Circulations



# LETTERS TO THE EDITOR



## Manual wanted

I am looking for a Service Manual for a Pye model SRC8022 radio cassette recorder, or any other spare service manuals. I will pay for photocopying, postage, or the manual itself. Can anybody help?

**Michael Edwards,**  
12 Wairoa Place, Tokoroa NZ.

## High speed modems

It used to be the practice to publish technical explanations as to how new technical systems work. This type of article seems to have become more rare with the passing years and is particularly true in regard to computers.

Some years ago telephone modems were introduced and, at first, these were either 300/300bps or 75/1200bps and the function was fully explained in popular magazines as this was the maximum width you could get onto a standard telephone line using minimum width FSK tone. Since then, the speed has steadily increased first to 1200/1200bps and now they are up to 33,600/33,600bps or more.

How on earth can they get two channels of 33,600bps on a telephone line which is only about 4000Hz wide? I have spoken to several people about this and many don't see anything unusual about it.

Perhaps you have explained it and I have missed it. I must admit I don't always see every article.

To change the subject completely, over the years I have built many *EA* kits, the last one being your 'Digital Storage Oscilloscope Adaptor'. One of the unique aspects of these kits is that they enable you to obtain relatively elaborate and less common instruments at a very reasonable price.

I would like to suggest that you consider developing a signal strength/field strength measuring instrument to cover from say 100kHz to 30MHz. Such instruments commercially are rare and expensive but could be quite simple to build. The essential parts for such an instrument would be a high gain but not necessarily good quality receiver, totally enclosed in metal and having no AGC. The output would be fed to a small loud-

speaker and a meter. The main parts would be a standard RF voltage source, standard E field and H field antennas (I would suppose there is an ASS, BSS, IEC or ASTM on this), and a calibrated attenuator to adjust the output voltage from the standard source. Too ambitious, you might say — but a lot of people built the Deltahet!

I hope you give both these subjects some serious thought.

**John Adcock, VK3ACA,**  
Oak Park, Vic.

## Circuits wanted

Could a help request be made through the magazine, for a circuit of a Teac 1200 reel-to-reel tape recorder, and also a BWD valve type CRO for a friend. The model number I think is a 500.

These requested have been on the BBS since 24 December 96 without any nibbles. Perhaps the wider circulation may produce a result. I can be contacted on (03) 9890 2117 AH or QTHR. Thanks,

**Craig Cook VK3CMC.**  
(Via the BBS)

## Modems & Win95

I would just like to respond to the comments of Robert Hunter in January 1997, re modem problems. The major disadvantage of external modems is that you need an enhanced com port to use the higher baud rates available. The solution is to use an internal modem, which is simple with Win95.

If you wish to retain the original Com1 and Com2, set the modem to use Com3 or Com4; however, this doesn't mean that Win95 will automatically detect it. The solution then is to install the appropriate com port via the Control Panel (Add New Hardware). Once this is done manually, Win 95 should be able to detect the modem.

Secondly, I would recommend that anyone using the Zip drive under Win95 should install a second parallel port for it. I have used the Zip drive on two Win95 systems — an older 486 and a new Pentium with enhanced parallel port. In both cases with the printer attached, I had slow operation with continued use and a tendency to crash. After



installing the second port (via Control Panel) all these problems disappeared. Of course, if you only use the drive to back up and install software, then this is overkill as the Guest programs supplied work well for these short term tasks.

**Graham P. Jackman**  
(Via the Internet)

## EMC Framework

My attention has been drawn to a 'News highlight' on page 109 of the October 1996 issue of *EA*, concerning EMI. Australia has had TV for over 40 years, and the SMA is proud of the fact that legislation is now in place, 'before it becomes a major problem'. What does the SMA in Canberra think the interference-chasing Radio Inspectors of the 1960's and 70's were doing when it was a major problem then?

How we envied the New Zealand radio inspectors, who had effective legislation to control EMI before they even had TV. What was even more galling was the fact that Australian electrical appliances made for the NZ market incorporated suppression devices, whereas those for the local market had none, as none were required for Australia.

Now, 40 years late, we have EMI regulations, and who is going to police them? The field staff in State and regional district offices have been retrenched and scattered; the expertise gone. Tens of thousands of old appliances still in use will continue to pollute the spectrum for years to come; audio amplifiers will be sensitive to RF fields for many years too.

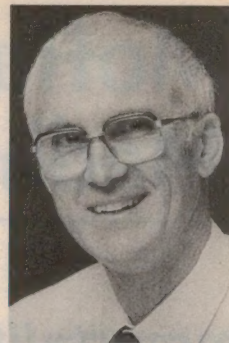
The SMA is but a paper tiger; it always was under its former names of the PMG Radio Branch, the Postal and Telecommunications Department and the Department of Communications, and I can see no difference now. It has abandoned many of its regulatory functions like the conduct of examinations, inspections and radio installation surveys.

I wasted 22 years working for them, and with State and District office staff cut back to the bare minimum, I fear it will be a long time before it improves.

**John H. Smith,**  
Glenroy, Vic. ♦

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of *Electronics Australia*. We welcome contributions to this column, but reserve the right to edit letters which are very long or potentially defamatory.

# EDITORIAL VIEWPOINT



## Many more changes ahead, in telecommunications

Over the last few years, in common with many other countries, Australia has seen many changes in telecommunications — not only technically but also in terms of services and providers. We've moved from having a Government-owned monopoly telco to a number of competing companies, and also from a situation where relatively few services were offered (based largely on 'copper wire and switches' fixed plant) to one where we're being offered an ever-broadening range of services — many of them involving optical fibre, digital, UHF/microwave or satellite technology.

It would have been hard to imagine the scope and impact of these changes, even 15 years ago. Could you have predicted the phenomenal growth of cellular phones, for example, or that of the Internet? But if you thought that we've now seen most of the changes that are likely to happen for a while, I'm afraid you'll have to think again.

The deregulation of Australia's telecom system was originally slated for July this year, meaning that we were already likely to see many more companies entering the market and offering both additional and alternative services. But now that the 70-odd member countries of the World Trade Organisation have finally reached agreement on a global Basic Telecommunications protocol, the reality is that from 1st January 1998, virtually every aspect of our telecommunications will be open to competition from around the world.

As I understand it, this means that very shortly, you'll be able to take advantage of any of the services and technologies on offer, regardless of the organisation offering them and where it hails from. So if you want to subscribe to the satellite phone services which will be offered by global organisations like Iridium, later next year, you'll be free to do so. Similarly overseas telcos will be free to set up here a network of base stations to serve the next generation of Personal Communications Service (PCS) phones. Your options are likely to increase dramatically as far as international phone calls are concerned, too.

The changes won't be just in the area of high-tech phone services, either. You can expect to be offered many more options with regard to wide band and interactive data services, too. Overall, the next few years are likely to see many more changes in telecommunications than we've ever seen before, both in terms of technology and services...

It's all going to be rather bewildering, and there'll probably be a downside — like further proliferation of ugly base station antennas in our environment, and more worries about EM fields. Some of our smaller home-grown telcos are very likely going to get clobbered by big operators from overseas, too.

But hopefully there *will* be at least two important positive outcomes: (1) The cost of just about all telecommunications services is likely to fall significantly, as a result of greater competition; and (2) Australia should be as up to date and competitive as any other country in the world, in terms of telecommunications services and costs. In fact we should at last become a full-scale member of the global telcomms community.

**Jim Rowe**



# Moffat's Madhouse...

by TOM MOFFAT



## Immortality — on the Internet

This month's column has gotta be one of the most self-indulgent things I've ever written. But, I guess it's a bit 'different'. It brings a whole new meaning to the word Madhouse, but in the April column we try to have a little fun. And maybe this will get you thinking about privacy issues on the Internet once again.

The idea follows from a posting on our local Internet discussion group, by a lady named Valerie:

*While playing with Yahoo's White Pages, I searched for my name and discovered that somewhere out there in the vast catacombs of cyberspace are postings to a newsgroup that I made back in 1994! There I am, making comments about software and about other people's opinions.*

*I always dreamed my writings would make me immortal, but to realize that whatever I have said over the net, over the years, might be out there, waiting to be searched and retrieved, is a bit sobering.*

What an interesting idea. Search for your own name and see what comes back. So I called up the excellent Alta Vista internet search engine, and sent it off looking for any reference to or about 'Tom Moffat'. What came back were 16 Tom Moffats, but only one of them was me. What about these other guys, pretenders to my name?

I won't detail every one of them here, only the more memorable ones. Starting with Tom Moffat of Honolulu Hawaii. There is a story behind this — I have known about the Honolulu Tom for many years, since a posting there in the mid-1960s on a space project for Sandia National Laboratories.

We were put up in a plush hotel, right on Waikiki Beach. And being young, single, and working for government wages, I was loaded. There were of course many opportunities to socialize with the local ladies.

"Hello, my name is Tom Moffat."

"Oh! Are you REALLY Tom Moffat?"

But of course, why shouldn't I be?

"Oh, Tom, I listen to your show every night, and I just LOVE it!"

Oh-oh. What gives here? Better play dumb, but better find out! It turned out that Tom Moffat was the most popular radio announcer in Honolulu, the star of station KPOL. Back then they called them disk jockeys, and young ladies fell at their feet. So I have *that* Tom Moffat to thank for opening many interesting doors for me during my Hawaiian stay...

Now back to the Internet: The Alta Vista search delivered a television news script, supposedly containing the name Tom Moffat. I had seen many of these before, and written many, and edited many, during my career in television news. Mostly my involvement within the scripts was something like 'This report comes from Tom Moffat'. Was this on-line script a throwback to my television days?

### Concert promoter Tom

No. It appears that the script was posted on the web site of Channel 2 in Honolulu; their way of providing on-line access to their daily television news. This stuff wasn't edited from the original scripts, it was just thrown in there, complete with vision and audio cues, for the public to read. Thus we had:

*Ticket sales were brisk and by early afternoon, Promoter Tom Moffat made this announcement.*

*Moffat: <11:08>- "We've just received permission from Michael Jackson's representative. To add a second show...Yeah." <11:14>- <BUTT WITH>- (Tom Moffat/ Concert Promoter) <12:38>- "They said go ahead. Put tickets on sale. We'll add the date and time as soon as we get everything together." <12:43>-*

Hey — Michael Jackson! Were seeing that Tom Moffat is mixed up with

Michael Jackson. Tom Moffat is Big Stuff — Honolulu's Harry M. Miller, or Michael Edgley. Same guy? Yep. A quick look on radio KPOL's web site revealed a station history, and their Tom Moffat, who started in 1959, was now 'promoting sports and other live events in Hawaii' (very successfully). So one of us Tom Moffats has hit the big time.

But, apparently not so for the Tom Moffat in Alaska. Here's what *his* search entry pulled up:

*Divorced 43 year old, 5'8", 165LB male seeks single or divorced women 25 to 35 years old, slim, educated, and marriage minded. Send replies to Tom Moffat, 746 Peck ST Wasilla, Alaska, 99654 USA*

Later on, he was reaching further afield:

*Hello Single ladies from Russia. I am seeking a beautiful woman between the age of 18 to 35 who would be interested in corresponding with a 43 year old man who is financially secure, with a nice home and is seeking a Russian lady for marriage.*

*Tom Moffat, Alaska, USA*

Where I live there are lots of people from Alaska. One reason men leave there is because there is a severe shortage of women. If that Tom Moffat can't find his mail-order bride, maybe he's going to have to move back to the big smoke.

If he comes to Washington, he is going to join an already overcrowded collection of Tom Moffats. This is really a quite uncanny situation — the odds of it happening must be enormous. As well as *this* Tom Moffat in Port Townsend, there is also one in Victoria, British Columbia, Canada. That's almost line of sight, only 58km from here. I already knew about *this* guy, through some misdirected e-mails.

And now the Internet search reveals another one, in a list of candidates standing for election for council in Richmond, B.C., just south of Vancouver.

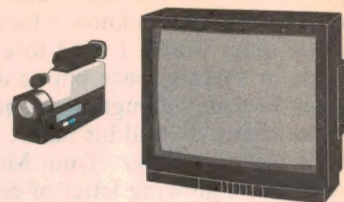
So this means, within a circle of per-







# What's New In VIDEO and AUDIO



## 'Monster' amp delivers 8000W

Professional audio specialists QSC have released the PowerLight 8.0PFC, an addition to the PowerLight range capable of delivering over 4000 watts/channel into 2 $\Omega$  and 8000 watts bridged mono into 4 $\Omega$ .

At only 3RU in height, 457mm deep and weighing under 23kg, the PL8.0 is claimed to represent the highest density of power ever achieved by a professional amplifier. QSC apparently engineered this massive power output capacity and compact size through several breakthroughs in power supply technology and output circuit design. Foremost among these was the first incorporation of power factor correction (PFC) in an audio amplifier power supply. PFC lowers peak AC current requirements by as much as 40%, reducing the strain on AC distribution. This is a critical issue for high-watt amplifiers, whose extreme power requirements can exceed available supplies — taxing the AC system, or limiting the amplifier's output.



The amplifier also features line and load regulation, making its peak power capacity insensitive to drops in incoming AC voltage. Other power supply features include true soft start, automatic AC overvoltage protection, and a frequency-invariant design that operates on any incoming AC frequency.

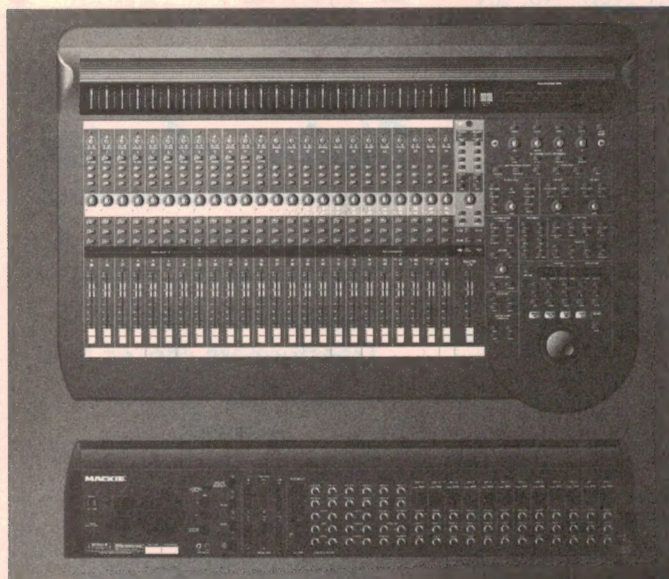
The output circuitry is also innovative. State-of-the-art high speed components and large-die, N-channel MOSFETs are combined with a four-tiered DC supply to yield efficiency comparable to class D designs, while operating in the linear mode for lowest distortion and noise. The extreme capa-

bility of modern MOSFETs is said to allow a 7:1 improvement over normal bipolar audio transistors. To further reduce space requirements, surface mount components are used extensively throughout.

Other features include a data port for amplifier monitoring, flow-through cooling with fully variable-speed fans, Neutrik Combo inputs and a standby mode.

For further information circle 144 on the reader service card or contact QSC distributor A.R. Audio Engineering, 558 Darling Street, Balmain 2041; phone (02) 9810 5300.

## Digital mixing consoles from Mackie



Los Angeles based Mackie Designs has announced a new series of digital mixing consoles called DIGITAL 8\*Bus, claimed to offer automation flexibility, DSP horsepower, feature set and versatility rivaling mega-consoles costing

\$200,000 and up. The new products have been produced by the firm's Digital Group, headed by a design team recruited from one of Britain's most respected manufacturers of digitally-controlled consoles.

A feature of the new designs is that the Digital 8\*Bus' control surface is designed to work like familiar analog consoles, so users can spend more time recording and less time 'pushing buttons'.

Over two years in development, the new 48x8x2 Digital 8\*Bus console has the features and sound quality for serious production work (including 7.1/5.1 channel surround capability) — yet is claimed to carry a retail price tag that makes it practical for home and project studios. It's also claimed to be an extremely easy digital console to use.

Offering a true 48-channel console complete with meter bridge, the console has built-in hard disk storage for effects libraries and automation sequences, 8MB of RAM, 24 channels of analog tape I/O and UltraMix II automation. Add a standard PC-compatible SVGA color monitor, mouse and keyboard for ultimate control of DSP parameters and automation. A DOS-compatible, floppy disk drive lets you back up and recall automation sessions — and instantly add DSP algorithms & future upgrades. Add up to three 8-channel digital cards for direct audio transfer to multitrack digital recorders. There's even a built-in modem for online updating of control software, etc.

For further information circle 142 on the reader service card or contact Mackie distributor Australian Audio Supplies on (043) 291 711.



## New VCR offers auto rewind, search

Panasonic has launched a new video cassette recorder with innovative user-friendly features.

A new function on the SD420 is called 'Intro-Jet Scan'. When the user presses the Search button on the VCR, the tape is immediately rewound to the beginning. It then plays back the first 10 seconds of each recorded programming in the CUE mode, in quick succession. When the desired program has been found, a press of the play button enables the VCR to switch over the normal play mode. This function is also convenient for cataloguing a video collection.

The new four head NV-SD420A has a restyled remote control which is compati-

ble with 12 popular brands of television. The remote also includes Panasonic's easy to use four-key timer programming, which enables the user to record their favourite programs by using individual keys for channel, date, start time and stop time. G-Code programming is also included.

The new SD420 is also compatible with other colour TV systems used overseas, so if the user receives an NTSC tape from countries like the USA or Japan the VCR will automatically make the adjustment and play back the cassette. The SD420 is also able to record in NTSC 3.58, so users can record and send a tape overseas.

The tuner of the SD420 is preset in the factory for all Australian television stations, to make it very easy to use 'straight out the box'. On-screen display



on the user's TV screen makes the SD420 easy to operate and program.

The Panasonic NV-SD420A is available from leading electrical retailers for an RRP of \$599. For further information circle 143 on the reader service card or contact Panasonic's Customer Care Centre on 132 600.

## CD recorder from Marantz Professional

Marantz Professional has released the new CDR 620 stand-alone CD recorder, with comprehensive and flexible facilities designed for a wide range of applications including recording studios, mastering, post production and broadcasting.

The unit features a built-in Sample Rate Converter (SRC) for recording directly from any digital sample rate between 32 and 58kHz; a digital audio input which automatically translates indexes from CD, DAT, MD and DCC with frame accuracy; a digital delay for exact positioning of indexing on either analog or digital inputs; and premium quality single bit Sigma-Delta A/D and D/A converters. It also includes a SCSI-II interface for con-



nection to most Digital Audio Workstations (DAWs) or any computer with a SCSI-II port. This interface, along with the appropriate software, enables the CDR 620 to record large quantities of data (up to 600MB) in one of the standard CD formats: CD-

ROM (XA), Photo-CD, CD-I, Video-CD and CD-DA.

The CDR 620 can also record certain formats at twice normal speed and be used in digital cascade mode, to transfer information simultaneously to multiple machines via a series of digital XLR connections.

A 34-key two way wired remote control (RC620) provides full control of all functions including index recording, copy prohibit on/off, SRC on/off, emphasis on/off, and ISRC and UPC/EAN recording, which are only accessible via the remote.

The CDR 620 has a retail price of \$9995, with a further \$795 for the RC620 remote. For further information circle 141 on the reader service card or contact distributors A.R. Audio Engineering, 558 Darling Street, Balmain 2041; phone (02) 9810 5300.

## 42" wide-screen colour plasma display

Fujitsu has released a leading-edge 42" wide screen colour plasma display panel (PDP) in Australia. The screen measures 920mm x 518mm, is only 150mm deep and weighs only 35kg — claimed to realise the long-awaited concept of a wall hanging TV.

The panel's 160° wide viewing angle ensures clear visibility from the outer edges of the screen and with precision full-colour display of 16.7 million colours, picture quality is claimed as 'superb'.

The plasma display consists of rarefied gas injected between two parallel glass substrates, the inner surfaces of which are covered with a layer of electrodes running parallel to each other. When voltage is applied between electrode pairs, discharge

occurs at the surface of the conductive layer and protective layer and ultraviolet light is emitted. This ultraviolet light excites associated phosphors, causing them to emit light.

Resolution of the panel is 852 horizontal pixels by 480 vertical pixels, with 256 colour levels for each red, green and blue pixel. Because of the completely flat panel, there is no image distortion on the screen. And since the panel is unaffected by magnetic interference, there is no image deformation or colour distortion due to the Earth's magnetic field, as often seen with conventional CRTs.

Equipped with analog RGB terminals, the panel can display VGA computer images through direct connection to a personal computer. As a wide-screen PC monitor, it can be used for various meetings and information systems or as a presentation tool.



Equipped as standard with AV terminals, it can also be used as a video monitor and accept input from various video equipment including VCRs, laserdisc players and camcorders.

For further information circle 140 on the reader service card or contact Fujitsu General (Aust.) Pty Ltd, on (02) 9638 5199. ♦



# SAMSUNG'S DVD-860 VIDEO DISC PLAYER



This month, reviewer Louis Challis has finally been able to try out one of the new Digital Video Disc (DVD) players. As far as we're aware it was the first sample unit brought into Australia, by Samsung — and very interesting it was, too. Quite apart from its video capabilities, it was darn impressive as an audio CD player!

The most exciting classification of equipment at the recent Consumer Electronic Show (CES) in Las Vegas were the new DVD players, with many examples visible on almost every major consumer manufacturer's display.

At the 1996 CES, there were only four different brands of working DVD players on display. In contrast at this year's show there were more than 20 brands on display, with many manufacturers displaying two or more models in the pre-release lineup.

If I had imagined that the majority of DVD players would simply be re-badged models from one or two market leaders, I was in for a rude shock. Whilst I am aware that the initial release of some smaller manufacturers are simply re-badged Toshiba, Matsushita, or Sony DVD players, the majority of the major manufacturers have already produced their pre-production, or first generation of working DVD players, and are ready to exhibit just what they can do.

In mid-1996, two local firms promised to provide me with either a re-badged Toshiba DVD player, or the first of their own 'in-house' DVD players for my evaluation by late

November. The promises proved to be little more than that, and as the appointed time came — and went — all I had were further promises which ultimately came to naught. Whilst discussing the problem with the sales manager of one prominent Japanese company, he mentioned that Samsung already had a DVD player in Australia, and were busily demonstrating it to their dealers.

When the subsequent promised DVD player failed to materialise, I decided to ring Samsung directly as I felt I had nothing to lose.

Almost before I had time to mutter the words "please may I borrow your DVD", I had the first working DVD player in Australia on my desk. More significantly, it arrived complete with suitable software to evaluate its outstanding functional performance.

The Samsung DVD-860 DVD/Video CD/CD Player which was provided turned out to be a 220 volt 60Hz model. It had been pre-programmed to accept NTSC software for Region No.3 (see Table 1)

Although I described some of DVD's more pertinent characteristics a year ago, during that period the ground rules have changed yet

again. A Cross-Industry Agreement of the major hardware and software providers was ratified late in 1996. The new agreement resulted in the adoption of an easy to use, high performance format. Put in its simplest terms, the new format satisfies the need of Hollywood, as well as those of the consumer electronics and computer industries.

The Cross-Industry Agreement has now received firm and unyielding support from the entertainment industry. The most important members of that industry are the seven major US film producers. The most important and implacable members of that group appear to be Time-Warner and MCA. It was they who formed the initial advisory group which laid down the critical requirements and film-orientated features of the DVD video system.

Whilst most of us were aware that the picture and sound quality must meet movie theatre standards, the revised DVD format now includes provision for multi-language dialogue (with the possibility of up to eight different spoken languages on a disc, supplemented by a subtitle capability which can in theory provide simultaneously 32 different languages).



Don't expect the first or even subsequent DVD software to embody all of those features. However what you can expect, and the feature which will be most exciting for the deaf members of our society, will be DVD's incorporation of English subtitles on virtually all DVD software from America, Europe, Japan and the vast bulk of other DVD software sources.

I am particularly gratified by that attribute, as heretofore the needs of the deaf have received scant attention from software manufacturers.

An additional feature which DVD incorporates is the provision of a 'parental lock' capability. Where the software incorporates violence, sex, or other features which parents may wish to exclude from their children's gaze, both the software and hardware will incorporate a simple means of restricting — or limiting access — to the required degree. The first generation software does not demonstrate that capability, but fear not; in later generations it will be incorporated as required.

Another exciting feature of the DVD video format will be its ability to provide 'multi-plot interactivity'. The incorporation of that facility will provide an unprecedented degree of 'user interaction' for children and adults alike. If you have played with a CD ROM encyclopedia, you will have some idea of what I am talking about — but what you have seen so far is only the tip of the iceberg. The 'multi-plot interactivity' potential of the forthcoming DVD software will provide multiple levels of complexity, multiple options or approaches to scenarios or plots in interactive games, and educational procedures which are truly exciting.

Of course, if you think the software industry is excited, the computer industry is equally enthusiastic about DVD. This technology will facilitate its drive into the multimedia revolution, 'hand in glove' as it were with the film industry.

DVD has been purposely designed to provide maximum cross-platform compatibility between DOS and/or MAC based systems and the latest generation of home entertainment systems. The pre-requisite compatibility will be ensured by a single file system, which supports both sequential and non-sequential data, with a common standard now adopted for both video and PC applications.

Unlike the first generation of CD ROM drives, neither a caddy nor a cartridge will be required for the DVD ROM discs. The DVD ROM drive will automatically read a CD ROM, as the form factor of both discs is identical. This approach ensures that PC manufacturers do not need to redesign their hardware. The logical approach to such problems has been further extended to the future writable and re-writable DVD formats, to ensure the appropriate level of cross-platform compatibility.

Of course the concept doesn't stop there, as backward compatibility is similarly ensured; so that all future DVD players will play the billions of existing music CDs. Whilst I note that most DVD manufacturers currently claim that their players will not play CD-R, or Photo CD discs, I have already

observed that the claim is not strictly true for all DVD players currently available.

It appears that the most critical functional characteristic of the final DVD file management system is its adoption of a single-volume Universal Disk Format. That format is based on ISO Standard 9660, which is an international standard accepted by all countries, and thus all current and future manufacturers. The new unified format finally discards the computer-based differences in file format, thereby ensuring the widest possible acceptance of the new standard in the multimedia field.

Of course, with a dual-layer format and a single sided disc, the disc capacity is a staggering 8.5GB (gigabytes). Even a single layer disc with its 4.7GB capacity can hold an (MPEG2 encoded) movie of up to 135 minutes length. That is equivalent to the data stored on more than seven audio CDs. The dual-layer disc almost doubles that capacity, with more than four hours of playing time being possible. The future double-sided discs will provide 9.4GB of capacity, and four hours 30 minutes of playing time.

The real secret behind the future success and flexibility of the DVD disc format is its adoption of the 'MPEG2' video compression format. MPEG2 gets its name from the Motion Picture Experts Group. They were the international Standards panel who developed the very sophisticated compression technology now simply described as MPEG2. MPEG2 allows the video data to be scanned and analysed, so as to minimise the need to store repetitive data.

95% or more of the scanned data in most video material is redundant. As a consequence it can be compressed by appropriate hardware and software with no noticeable (observable) adverse impact on the resultant picture quality.

## TABLE 1: DVD Regional coding

In late 1996, the International Committee of Hardware and Software manufacturers nominated the following regional coding systems for DVD:

**Region 1: North America (USA and Canada)**

**Region 2: Latin America Oceania**  
(including Australia, NZ)

**Region 3: Japan, Korea**  
and Europe

**Region 4: South East Asia (Excl. China)**

**Region 5: Others (Russia and Africa)**

**Region 6: China TBC**

The software formulation for each region has been carefully selected by the International Committee of Hardware and Software manufacturers, so as to minimise the possibility of pirating or illicit marketing of any specific area's software into another region.

the minimisation of cross-colour distortion or colour edge bleeding.

If you examine a pre-recorded video with your own TV set, where there are strong reds, and sometimes strong greens, you will invariably note that the reds smear into the contrasting colours of adjacent areas on the TV or monitor's screen.

In sharp contrast to your VHS recorder, there is a dramatic improvement in the quality of colour rendition from DVD. I was immediately aware of the absence of streaking and other nasty visual artefacts which plague VCRs. The digital video components which provide the signal for colour and intensity distribution are separately logged in the digital signal on the DVD disc.

The sound system for the Region 3 encoded DVD discs has adopted the 5.1-channel of Dolby Digital format (or what was previously known as the AC-3 surround sound system).

Since 1992, the AC-3 audio compression technology has been adopted in most major feature films. The sound track is positioned between the sprocket holes on the 35mm film prints, (as apparently there was nowhere else to put it).

Just in case you hadn't noticed, the sound quality of most of those films has been excellent (sometimes outstanding), with the typical frequency bandwidth approaching 19kHz. The most obvious and dramatic difference between the sound tracks on those films, and other contemporary films, is the quality of their low frequency sound. Their performance frequently rivals that of the infra-sonic sub-woofer systems used for the film 'Earthquake'. I measured the characteristics of two of the cinemas in which that particular film was shown, and recorded peak sound pressure levels as high as 125dB, at frequencies that were as low as 15Hz.

NTSC Picture + Dolby Digital Sound  
PAL Picture + Dolby Digital Sound

NTSC Picture + Dolby Digital Sound  
PAL Picture + Musicam Sound  
Details currently unstated  
Secam Picture Sound system not defined  
Details currently unstated

A DVD player configured for Region 3 accepts NTSC-based software. The player is capable of achieving a genuine 500 lines of horizontal resolution, which is substantially better than the 430 lines provided by analog laserdiscs, and even better than the 400-line resolution of an S-VHS video recorder, when replaying NTSC formatted tapes.

That video performance is supported by a superior signal to noise ratio, thereby ensuring that there is a smoother natural gradation in whites and blacks. Whilst the differential white and black performance is identifiable, what I consider to be far more important, is

One intriguing feature of the Dolby Digital encoding system is that it has been designed to provide a mixdown of Dolby's four channel Pro-Logic soundtracks, or stereo soundtracks, as alternatives to the full 5.1 channels of sound normally furnished.

The latest information that I have received from Philips claims that the PAL standard DVD videos which will be issued in Region 2 (i.e., Australia and New Zealand), will use the Dolby Digital sound system, and not the PCM three-channel audio option which was previously mooted.

One notable DVD feature which has only



recently been resolved is the adoption of user-selected screen display formats. Standard TV screens have a width to height aspect ratio of 4:3. By contrast most modern films are now formatted with a nominal aspect ratio of 16:9, to suit the wider theatre screens.

If a film or video is recorded with the 16:9 wide screen format, and a TV station broadcasts it, the sides are generally cut off when the film is viewed on a standard TV set — unless it's broadcast in reduced 'letterbox' format. Although you may well have seen Philips wide screen TV sets with 16:9 aspect ratios, those TV sets only really provide optimum performance when displaying a video that was recorded with the same aspect ratio.

The hardware manufacturers have now responded to the software manufacturers and film companies' needs. The DVD system provides you the viewer with the option of selecting a conventional aspect ratio of 4:3, or the 16:9 wide aspect ratio, as well as a 'pan & scan' format in which the edges of the film are cut off.

The resourceful aspect of these options is that your DVD will allow you to view any, or all of these options so that you can achieve the maximum possible resolution on your TV set or monitor.

Not surprisingly, Samsung appear to have gone one stage further than many of their competitors. They have developed a TV set which has a wider screen than that of the conventional 4:3 format. Their new TV set (which we hope to review shortly) provides the option of seeing a 'pan & scan' film to maximum advantage with a screen that Samsung describes as 'The World Best Plus', which has a 12.8:9 width-to-height ratio.

## The Samsung player

Samsung's DVD-860 has a frontal appearance which is not unlike many high quality CD players. The major difference is that it is somewhat wider, and of course emblazoned by the DVD video symbols and other annotations which provides more than a few clues to its real purpose in life.

The front panel offers an ergonomically simple and straightforward approach for the basic controls to which you normally require rapid access. At the left-hand side of the panels is a power ON/OFF switch, on the right-hand side a large circular disc, with four quadrants providing the following controls. At the top is PLAY/PAUSE, at the bottom STOP, on the right-hand side FORWARD/SKIP/SEARCH, and the left-hand side REVERSE/SKIP/SEARCH.

Only two other pushbutton controls are provided on the front panel, the upper one being for the brightness control of the fluorescent display, and the lower for tray OPEN or CLOSE.

The centre of the display provides a wealth of information, with large alphanumeric read-out of TRACK No, PLAYING TIME and other textual information — including various warnings — and last but not least 'BYE-BYE' when you reach the end of the disc.

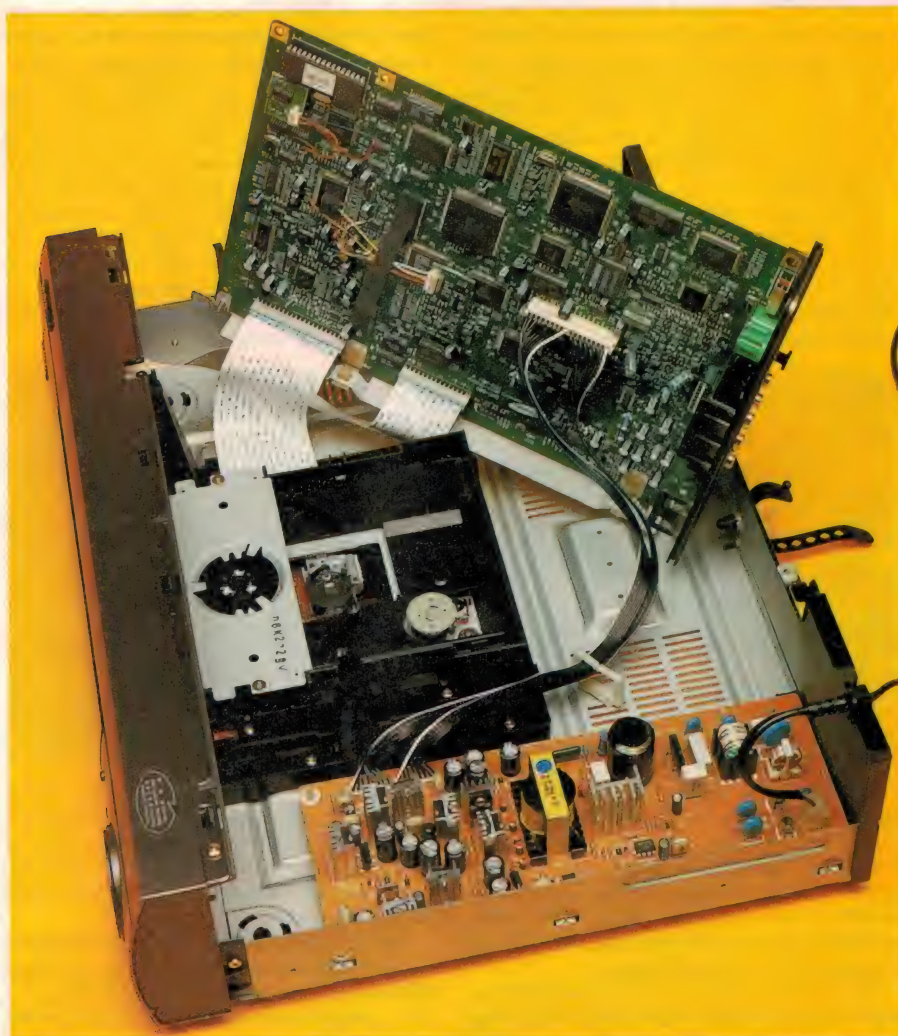
On the player's back panel the mains cable is hard wired. A switch is provided for selection of AC-3 or PCM audio output and two coaxial plugs are provided to interconnect the DVD player to an integrated control system. An optical digital video output socket is provided, a digital audio output is provided, plus four channels of analog audio, two channels of video and an S-video output.

The remote control has a multiplicity of controls which integrate the normal input selections, numerical program selections, volume and channel selection and various special purpose functions including TIME SEARCH, an AUDIO pushbutton to select the language, SUB PICTURE and DISPLAY to select the type of picture, and MENU to select a range of options. In the lower central quadrant of the remote control a circular grouping of five controls provides functions of UP, DOWN, LEFT and RIGHT and ENTER for your interactive control functions, below which are a standard set of functional controls which are applicable to conventional CD players.

With the DVD player's lid removed, the first thing that caught my eye was the large centrally positioned printed circuit board located immediately below the underside of the metal cover. The electronic components are all mounted on the underside, so as to obstruct direct examination of their annotation and details.

By using a mirror I avoided the need to disconnect the circuitry to identify the active semiconductors and components mounted on the board. This revealed that it contains an extremely large number of high-density LSI chips, one of which was cryptically annotated 'DVD Version 860, Version 1.03'.

Whilst a large proportion of the special-purpose chips were manufactured by Toshiba, the printed circuit boards, power supplies and the vast bulk of the other components on the board appear to be manufactured by Samsung or its subsidiaries. I was able to confirm that this DVD player was not a case of 're-badged' product from another manufacturer.



**Inside the sample Samsung DVD player. The laser pickup is visible in the centre of the disc mechanism (centre left), and many ICs can be seen on the signal PCB we've swung upwards. At bottom is the power supply PCB.**



My inspection revealed that Samsung have gone to considerable trouble to minimise electrical interference between individual sub-sections and components within the chassis. This DVD player has been pragmatically designed, with significant emphasis being placed on simplified maintenance access to every major sub-section and component of the unit.

## Testing it

In the absence of special objective test software for a DVD player, I was forced to employ conventional CD test discs from which I selected what I regard as being the 'most telling of tests'.

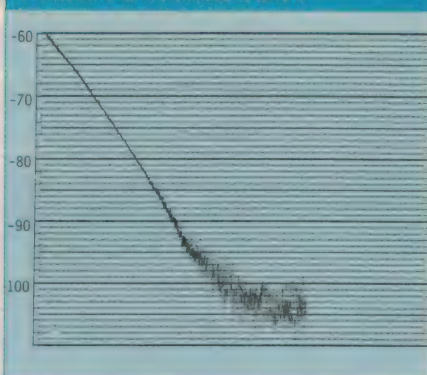
The replay frequency response tests generally provide a good indicator of the fundamental design philosophy and functional characteristics of the digital to analog converter and its downstream filtering circuitry. I soon discovered that the frequency response using a swept signal covering the frequency range 5Hz to 20kHz displays a response which is 4dB high at 5Hz, but then gently slopes down to reveal a response which is flat within  $\pm 0.1$ dB from 50Hz to 20kHz.

There may well be some good reason for adopting a rising low frequency response, but the answer to that question was not readily available, particularly as the critical background literature is currently only available in Korean.

The DVD player's digital/analog conversion linearity was then critically evaluated over the range 0dB to -90dB. I was pleased, and a trifle surprised to observe the smoothest D/A linearity response curve of any CD player I have yet examined, independent of its price. Although the player displayed a 0.4dB nonlinearity at -80dB, it still exhibited a superb linearity which was only 0.1dB high in the left channel, and 0.2dB high in the right channel at the -90dB point.

Heartened by that result, I progressed to a fade-to-noise test. Not surprisingly, I then observed one of the smoothest fade-to-noise tests I have yet seen. The graph is remarkably smooth all the way down to -96dB. Below that

## FADE TO NOISE TEST



point, the inherent background noise dominates the residual bits left in the slowly diminishing test signal.

An evaluation of the total harmonic distortion again revealed excellent performance, although admittedly not quite as good as the best and most expensive CD players we have tested. However it would not be fair to compare the performance of those units, which would have a selling price of three to 10 times that of the Samsung DVD player.

Of all the tests that I normally conduct, the one which undoubtedly separates the 'men from the boys' is the black-stripe or dirty disc test. With a special purpose Sony CBS test disc, the results were reasonably good, with the disc happily tracking a 1.5mm wedge — which is now regarded as a normal performance for most quality CD players.

Of course the standard CD test disc does not assess the DVD laser's ability to track data with nominally eight times the density. As we subsequently observed, with DVD software the presence of dust or fingermarks on the disc can affect trackability.

## Viewing & listening

Satisfied that the Samsung DVD 860 player's performance as a CD player was well above average, I carefully repackaged it into its cardboard carton, and took it and the three

## MEASURED PERFORMANCE OF SAMSUNG DVD 860 PLAYER

S/N 621GB00161 (Region 3 player supplied, with 220V/60Hz and NTSC operating parameters)

1. Replay Frequency Response: 5Hz to 20kHz +5dB -0.1dB

### 2. Linearity:

Nominal Level	Measured Output L Channel (dB)	Measured Output R Channel (dB)
0dB	0.0	0.0
-1.0	-1.0	-1.0
-3.0	-3.0	-3.0
-6.0	-6.0	-6.0
-10.0	-10.0	-10.0
-20.0	-20.0	-20.0
-30.0	-30.0	-30.0
-40.0	-40.0	-40.1
-50.0	-50.0	-50.1
-60.0	-60.0	-60.0
-70.0	-70.1	-70.1
-80.0	-80.4	-80.4
-90.0	-89.9	-89.8

### 3. INTERRUPTION IN INFORMATION LAYER:

Tracks interruptions on conventional CD test discs with width up to 1.5mm

**NB:** Dust or surface imperfections do affect the tracking capabilities when replaying DVD discs.

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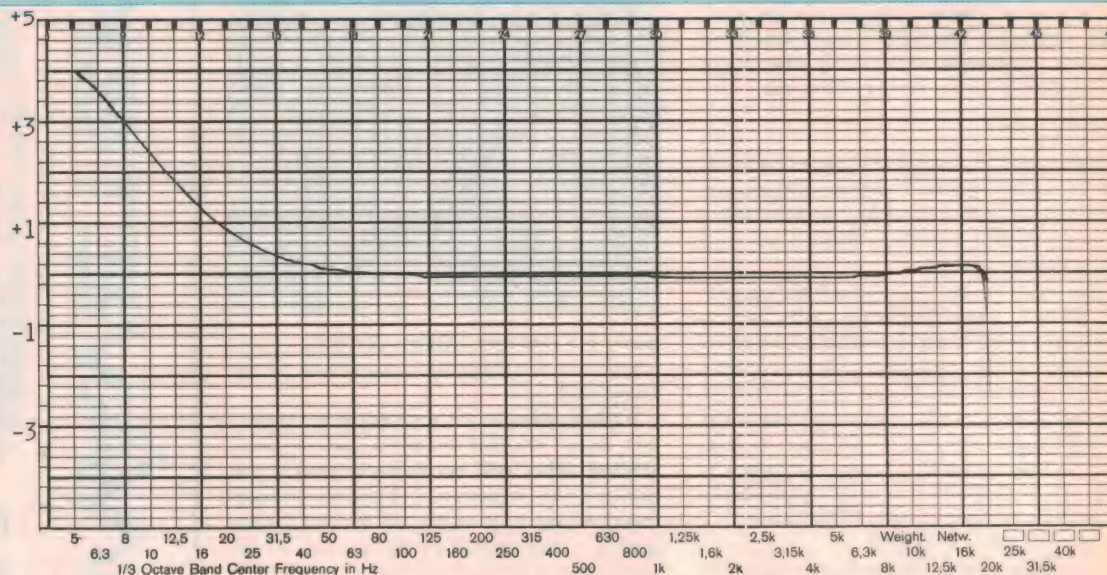
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READER INFO NO.3



## REPLAY FREQUENCY RESPONSE

The measured audio replay response is within 0.1 dB from 50Hz to 20kHz, but rises to a peak of around +4dB at 5Hz. The reason for this low-end rise is not clear. The fade to noise curve (previous page) reveals a very linear D/A characteristic.



test discs provided home for a more substantial, subjective test.

Prior to receiving the Samsung DVD player, and not knowing whether it incorporated its own AC3 decoder hardware, I borrowed a Harman Kardon Model ADP303 Audio Digital Processor and a Model AV1250 Audio/Video Amplifier. Later I discovered that the DVD 860 fortuitously incorporates its own Dolby Digital decoding system, so I only used the Harman Kardon Audio/Video Amplifier to assist me in my subjective evaluation.

The software provided included a demonstration disc with carefully selected pre-recorded excerpts, which demonstrated the following characteristics:

1. The interactive potential of the DVD 860 player, and specifically your ability to select which language the soundtrack will be played in.
2. A 'user-selectable' option to display subtitles in any one of up to eight languages. The subtitles can be in a different language from the audible soundtrack. This of course is an absolute boon for the deaf, and may well prove to be an equally desirable feature for language students.
3. Alternative display format for the picture, which may be in 16:9 wide format or conventional 4:3.
4. The ability to advance or 'skip' and search for specific program material on the basis of track number, and in subsequent specific segments or content on a disc, determined by the interactive pre-encoded software you happen to be viewing or using.

One of the outstanding feature of the demonstration software was the high resolution displayed by the video picture. I was using a 15 year old Sony 'Profeel' monitor, which accepts NTSC formatted video. I noted that there was absolutely no trace of colour bleed, and the picture quality clearly rivalled that provided by a PAL encoded laserdisc. That observation only confirmed what the

manufacturers claim.

When the PAL version DVDs arrive with their 625-line pictures, the horizontal resolution and overall picture quality will hopefully be just that much better again.

I loaded the only full length DVD feature film provided, an American B-Grade film entitled *Cut Throat Island*. It's not the sort of film I would normally go to the cinema to see, I hasten to add. Notwithstanding my disdain for the film, the visual quality was excellent, and the soundtrack when replayed using all 5.1-channel capabilities was exceptional.

OK, I didn't enjoy the film — but I must admit that I was impressed by what it illustrated. Whilst I briefly played with format, choice of language, subtitles, etc., when viewed in the context of a home theatre system it surpasses anything I have yet seen other than the expensive Farudja line doubler systems — and of course, the high definition television sets which are unlikely to go commercial for at least another decade.

I expanded my subjective evaluation of DVD with a media preview which I attended at Brash's main Sydney store the following week. That demonstration impressed me how important it will be for the promoters of DVD to 'hasten slowly' until the appropriate software is available for the formal launch.

With only three days available to objectively and subjectively evaluate the DVD 860 player, I only had a brief opportunity to listen to CDs and find out how well the DVD player performs when devoted to what may well prove to be its major function.

The first CD I played was Richard Leech's 'From the Heart' (Telarc CD-80432), which is an exciting potpourri of Italian arias and Neapolitan songs. This is an outstanding disc initially recorded with 20-bit resolution, and its replay performance was audibly superior to that which I have come to expect from quality CDs and comparable CD players.

I progressed to a recent release of

Rossini/Respighi's Ballet 'La Boutique Fantasque' (Telarc CD-80396), with Jesus Lopez-Cobos and the Cincinnati Symphony Orchestra. It too was originally recorded with a 20-bit resolution, and re-encoded as a 16-bit signal. The DVD 860 player provided a superb replay capability, and confirmed the outstanding performance of the DVD 860 as a CD player.

## Summary

The peripheral advantage of any DVD player will be its ability to fulfil the dual roles of a DVD and CD player. In the absence of this multi-functional capability, and in the absence of appropriate software, DVD would soon be relegated to a relatively minor and inconsequential position in the marketplace. The information which I am even now receiving, confirms that all segments of the market are adopting a consistent and unified position on these issues. The hardware will be available, but it will only be released together with the critical software.

The DVD 860 player has whetted my appetite as it has confirmed that DVD is the next wave in consumer electronics. This is a medium which is still 'over the horizon' as far as the vast bulk of Australians are concerned.

On the basis of the limited testing which I have conducted, I am satisfied that DVD can deliver the goods. It now remains a matter of some conjecture whether the Australian public will accept DVD with either a comparable or greater degree of alacrity that it has displayed for cable TV.

The Samsung DVD 860 measures 420 x 339 x 120mm (W x D x H), and weighs 4.2kg. At present there is no information regarding price or availability.

Further information may be available from Samsung Electronics Australia, 10 South Street, Rydalmere 2116; phone (02) 9638 5200. ♦



# SHORTWAVE LISTENING

with Arthur Cushen, MBE

## Reflections on the pioneer radio listeners

In the past few months international broadcasters have celebrated anniversaries of their operation, and in New Zealand last November, special programmes on radio and television marked 75 years since the first NZ broadcast took place.

The pioneer was Professor Jack at Otago University in Dunedin, who on November 17, 1921 broadcast the first known music on radio in this country. However little has been written about the pioneer listeners who, faced with prosecution for possessing wireless equipment or even knowledge, opened the field for the listening hobby back in 1911.

One of those pioneers was Arthur McClay, who was born in Ceylon in 1897 and along with his family arrived in Wellington in 1905. Their home was in Gordon Place, Newton, Wellington and they had a cottage at the back of the property. It was here that young Arthur began experimenting with radio listening. He used this building up to 1914 and after the end of World War I in 1922, established 2YK, the forerunner of 2YA.

Arthur McClay was at Wellington Boys College in 1911 and was interested in science. He also became interested in wireless and although at the time it was illegal to possess equipment, with a £500 fine or six months imprisonment, Arthur was able to secure from visiting ships pieces of equipment in order to enable him to listen.

There was very little available on the theory of wireless. Arthur was able to build a

primitive receiver and began listening to spark transmissions, and each evening after dark would pull up his antenna and extend his range of reception.

He was out one evening walking and saw a young man also pulling up an aerial. Arthur was overcome with joy and amazement in discovering another young man with the same interest, and promptly made himself known to Guy Tinney. On another occasion he found another would-be radio listener, Brian Robinson, and the three of them joined from 1911 to 1914 to enjoy this hobby. Arthur was able to see Brian's receiving and transmitting equipment and he also saw a replica of a standard Telefunken receiver which Brian had made. As an electrician, Brian Robinson visited ships that came into Wellington and was able to secure a considerable amount of equipment.

Arthur McClay learnt the Morse code, but he was not interested in sending, only receiving ship signals. The two men took good care that their aerials were always out of sight during daylight hours and operated only at night time. By 1912 the two met regularly and at that time they agreed that they were the first DX long distance listeners in the country.

### Distress signals

One exceedingly bad night in June 1912, gale force winds swept Wellington. The rain came down in torrents. It was such a bad night that Arthur decided to go to bed early, but around midnight he was woken when

Robinson informed him that there was a ship in distress in the Wellington Harbour. The ship had steering trouble and was out of control, and drifting towards a reef.

It was known that the Wellington Wireless Station was out of operation and the two pioneer listeners had to make a quick decision — as the situation they were placed in, being lawbreakers, could mean severe consequences. They contacted the Wireless Telegraph Station, informed them of the ship in distress and the ship was brought into safety.

The next day, the two were advised that action would be taken against them. But fortunately the then Minister of Justice, Mr Thomas Wilford, intervened on their behalf and conferred with the Chief Telegraph Engineer. It was decided that the law be changed immediately to allow citizens to own and operate wireless receiving equipment, subject to control and yearly registration. The three Wellington listeners received their licence to own and operate a radio receiving set anywhere in New Zealand. In 1914, at the request of the Post and Telegraph, their equipment was dismantled and they remained silent during the war years.

The spark transmissions they received in those days were mainly from trans-Tasman ships. Also the Government in 1913 had opened two wireless stations for ship communication and they were installed by Telefunken — one being at Awarua, near Invercargill. The Telefunken and Marconi transmitters were the only two in operation and their distinctive Morse signals became well known to these early listeners.

In 1922, Arthur McClay set up 2YK Wellington, now National Radio 2YA on 567kHz. 2YK was one of the pioneers in early broadcasting in this country, operating from its inception at the site of his early radio listening on his parent's property in Wellington. This reminiscence of early listening was made from an interview I had with Arthur McClay in 1984. ♦

## AROUND THE WORLD

**ANGUILLA:** Caribbean Beacon 1610, often heard in the South Pacific, is being joined by a new station on the island. Has been testing with a 100kW shortwave transmitter on 6090kHz at 0800UTC, mixed with Chile Radio Esperanza also testing on 11,775kHz. The station is owned by Dr Gene Scott.

**DUBAI:** UAE broadcasts in English at 0330-0400 on 13,665kHz, also announces 11,945kHz, 15,400 and 21,485kHz.

**FRANCE:** RFI, English is scheduled 1200-1300 on 11,600kHz; 1500-1600 on 12,030 and 15,405kHz to South East Asia; and 1600-1700 on 9485 and 11,615kHz to Africa.

**GUAM:** KTWR is heard in English 1000-1200 on 9870kHz.

**IRAN:** VOIRI, Voice of the Islamic Republic of Iran (PO Box 19395-6767, Tehran, Iran) is heard with English 1530-1630UTC with news at 1530, then political talks, news at 1615, followed by a travel talk, and complete schedule at sign off. The station is using 9635kHz.

**NIGERIA:** Lagos is heard at 0600 on 7255kHz with tone, no announce-

ment and then straight into music, mainly of an African nature.

**SRI LANKA:** Radio Japan's Sri Lanka relay is in operation and they are heard 1300-1400 on 12,045kHz; 1700-1800 on 11,880kHz; and 0100-0200UTC on 11,890kHz. These relays replace the former Yamata and Gabon frequencies.

**SUDAN:** Radio Omdurman has sign-on at 1900 on 9200kHz. The station announces as the English Service of the Sudan National Radio Corporation External Service. Broadcasts are 6-7pm local time (1600-1700UTC) on shortwave in the 41-metre band on 7200kHz, and English and French are half an hour each. There is an English and French Service 7-9pm (1700-1900), one full hour each on shortwave in the 31-metre band using 9200kHz and mediumwave 576kHz. "You have been listening to the Sudan National Broadcasting Corporation, now signing off."

**USA:** WINB in Red Lion PA, on 50kW, came back on the air in January 1700-1900 on 15,715kHz; 1900-2200 on 11,740kHz to Europe; and 2200-0300 on 11,950kHz to Mexico. ♦

*This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and short-wave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time and 12 hours behind New Zealand Standard Time.*



# AUTOMOTIVE ELECTRONICS



with JON LOUGHRON Assoc. Dip. Electronics

## The Wolf 3D Engine Management System - 2

This month we're continuing our look at the Wolf 3D engine management system, from Advanced Engine Management (AEM). We look more closely at the trigger system, configurations and additional features of this well-designed 'aftermarket' system.

As I was writing this month's article the fax machine burst into life — whirring, buzzing and wheezing (not me, the fax machine). I looked into the fax output tray and read the notes with anticipation, because it was from the engineers at AEM. This was particularly good timing because apart from being able to tell the rest of the story about their whizzbang box of electrons, I can now also inform you about the very latest updates to the 3D system.

### Ignition & triggering

Last time this system was discussed, I covered its basic functions and configuration. This month we will look at specific ignition configurations, software set up and menus. As previously mentioned the Wolf 3D can be configured to run various types of ignition systems.

The unit can be configured to run 'injection only', and in this configuration the negative side of the coil then provides the system trigger. Every time the coil fires, the primary ignition signal is sent to the ECM and from this signal the ECM calculates the RPM and injection timing. This type of configuration will mean that ignition timing and dwell is achieved external to the 3D unit — normally determined by mechanical means inside the distributor. There may be points in the distributor or an electronic pulse generator (and module) with a swivel plate to provide the ignition advance.

The next type of ignition configuration that the 3D unit has provision for is ignition timing, with advance/retard controlled internally by the 3D unit, and spark implemented via a distributor.

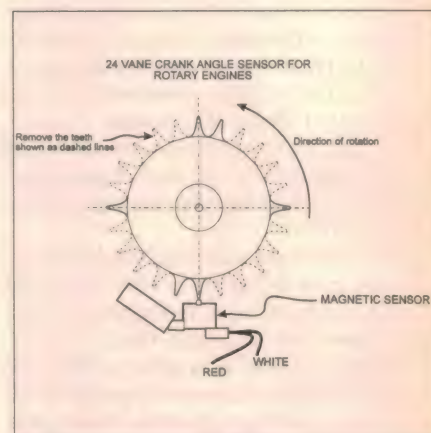
An external trigger is necessary in this configuration because if the ECM controls the ignition output, then it cannot also use the ignition system as the input trigger. (What came first, the chicken or the egg?)

The trigger for the system can be obtained using various methods. The original pulse generator inside the distributor can be used, or another trigger plate can be grafted onto the system to provide relative crankshaft position information. An example of using the original distributor as the trigger is provided in Fig.1. This shows a distributor for a Mazda rotary system and the modifications necessary to integrate the 3D ECM.

An external ignition module must also be employed in this mode of operation, because the ECM will not sink the current required to drive the primary side of the coil. Frankly I think that having an external ignition driving stage is a good idea, because whilst I have been employed in the field of automotive electronic repairs, I have noticed that some OEM engine management ECMs (Electronic Control Modules) have expensive internal ignition output stages. Some are quite rare, so repair is sometimes not practical and replacing the entire unit with a new ECM is a very expensive alternative — whereas an external ignition module can be replaced at a much reduced cost.

The updated version (version 2) of the 3D has internal ignition power drive stages and this again reduces cost. I am assured that they are readily available at a reasonable cost if a unit does need to be repaired — due to a short circuited ignition coil or any wiring faults.

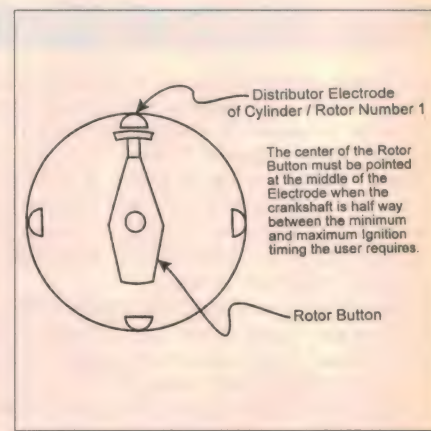
When using a distributor to distribute the spark, the distributor advance/delay timing plate must be locked into position because the ECM now controls the timing. The distributor must be set up in such a way as to allow as wide as possible ignition timing range. This is achieved by positioning the rotor button pointing directly at the number one cylinder post/electrode in the distributor cap, while the crankshaft is positioned



**Fig.1: The Mazda rotary distributor can be modified as shown to supply the system trigger signal.**

half-way between the minimum and maximum required ignition timing.

For example if the required ignition timing is to be adjustable from 0 - 40° BTDC (before top dead centre), the rotor button must point directly at the number one cylinder when the crankshaft is at 20° BTDC.



**Fig.2: With the distributor timing plate locked into position, the 3D unit looks after ignition timing.**



Fig.2 illustrates the direction of the rotor button. The same theory applies to rotary 4, 6 and 8 cylinder vehicles. Once the distributor is locked into the correct position, the WOLF 3D can take over the required ignition duties.

## Multi-coil ignition

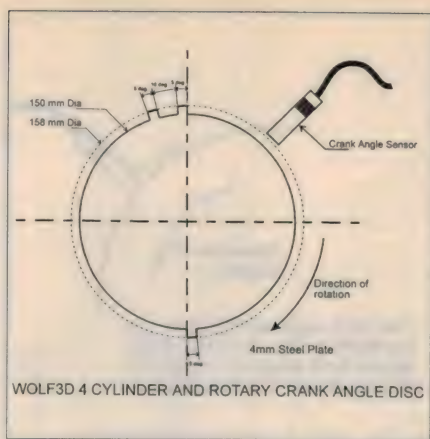
The last ignition configuration available on the 3D is crank triggered multi-coil ignition, where each cylinder may have its own coil, or a pair of cylinders may have a shared coil (redundant spark). If you look under the bonnet of late-model Commodores or EF Falcons, you will notice that they both have six cylinders and only three coils.

When using this mode the original distributor may be removed altogether, because as mentioned above each cylinder may have a coil so central spark distribution becomes redundant.

However with the distributor removed, we now have to provide some sort of crank reference for the ECM. This is achieved by installing a disc as shown in Fig.3 (four cylinder and rotary), to be mounted on the front of the crankshaft. Some late model engines may have a similar trigger plate and sensor arrangement, but the plate may have to be replaced — although the sensor may still be used. The equivalent six- and eight-cylinder crank angle discs are shown in Fig.4.

The crank angle disc does not have to be exactly 158mm in diameter, but the teeth angles of 5° and spacing of 10° must be maintained, with a constant 4mm tooth height also a high priority.

False triggering is a problem in any automotive system, so a few precautions must be observed — such as shielding the trigger wires and not running the triggers too close to the secondary wiring of the ignition system.



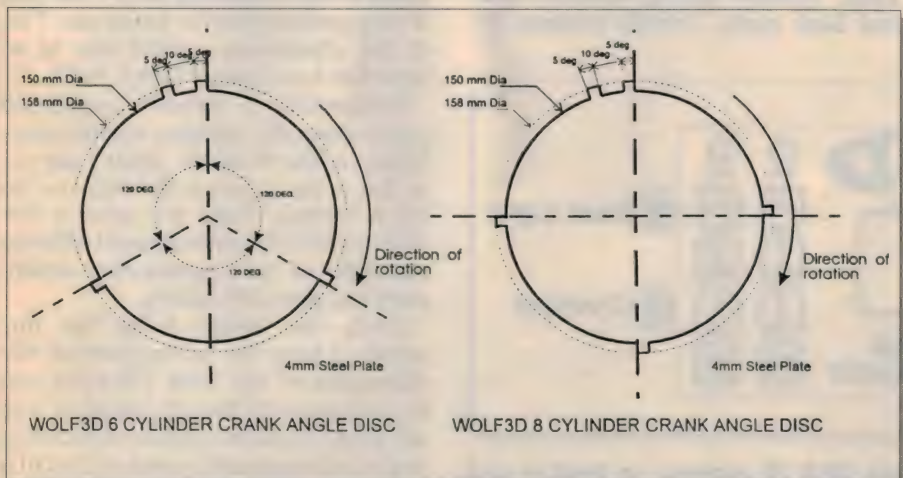
**Fig.3: The crank angle trigger disc required for using the Wolf 3D with four-cylinder and rotary engines.**

When mounting the disc, ensure the mounting screws are not too close to the perimeter of the disc. The disc must also be accurately centered to ensure that it runs true.

The position of the crankshaft trigger disc in relation to the crank angle sensor is very important. The disc has one set of double teeth and 1, 2 or 3 single teeth, depending on the number of cylinders. The double teeth must pass the crank angle sensor 60° before the engine reaches top dead centre of cylinder/rotor number 1 (see Fig.5).

After the double teeth pass the sensor, the WOLF 3D delays the signal until the appropriate crank angle has been reached. The ECM then fires the ignition coil/coils at the user defined angle.

Setting a basic ignition map must be done before any fuel values are set and in the manual a very basic ignition map is provided as a general reference. The final values may be very different from the initial values, but there must be a starting point.



**Fig.4: The crank angle trigger discs needed for six- and eight-cylinder engines.**

## Dwell control

As mentioned before, an external ignition module can be used to drive the coil. Some of the external modules, such as the Bosch '024' module, have internal dwell control (see *EA* January 97). If a driving stage is used that does not have dwell control, this is not a problem with the WOLF 3D unit because dwell control can be achieved by the external module or provided directly from the ECM. The ECM can control the coil charge time over the range from 1.0 to 5.0 milliseconds and is adjustable in 0.1ms increments.

Setting the dwell control is a very precise science and should be done with dedicated automotive test equipment. So if you don't want the hassle or don't have the correct test equipment, use an external module like the 024 with internal dwell control and set the dwell to 3.8ms (information conveniently supplied by AEM).

It can be seen from the previous paragraphs that good ignition control can be achieved by the WOLF 3D. There are a few variations available, depending upon the dollars available and performance required.

## Menu system

This brings us to the discussion of the menu system. The WOLF 3D has quite a powerful menu selection considering that all the information is entered into the unit by the hand controller — except when an external memory cartridge is being used. So I should say that the initial information is entered using the hand controller.

The menu section is interesting because it gives a general overview of how to program the unit and also the flexibility of control available. The summary basically covers the functions of the eight keys on the hand controller. The keys have a main function, then once this function is selected a sub menu is presented and a choice can be made. Fig.6 shows the buttons on the hand controller.

**SET:** Stores modified parameters and Map values and Arms the security function. The first button press forwards the display to the Bargraph screen, while a button press brings up the Map Transfer screen.

Map Transfer sub menu:

- 1 - Computer reads the internal fuel and ignition maps.
- 2 - Computer reads fuel and ignition maps from the external cartridge.
- 3 - Save map to cartridge.
- 4 - Load map from cartridge.



## AUTO ELECTRONICS

**CLEAR:** Returns to the main screen from any menu (no values saved) and disarms the security function. Returns to the main screen from any menu choice.

**1/START:** Starting and staging functions (Map step function load down)

- 1 - Cranking fuel rate.
- 2 - Cranking ignition timing.
- 3 - Auxillary injector staging.

**2/LIMITS:** Operation limiters

- (Map step function load up)
- 1 - Over rev limit.
  - 2 - Over temp warning.

**3/INJPAR:** Injection parameters

- (Map step function RPM down)
- 1 - Acceleration enrichment rate.
  - 2 - Acceleration enrichment sustain.
  - 3 - Cold enrichment.
  - 4 - Overrun injection cutoff.

**4/IGNPAR:** Ignition parameters

- (Map step function RPM up)
- 1 - Coil charge time.
  - 2 - Trailing pulse for rotary application

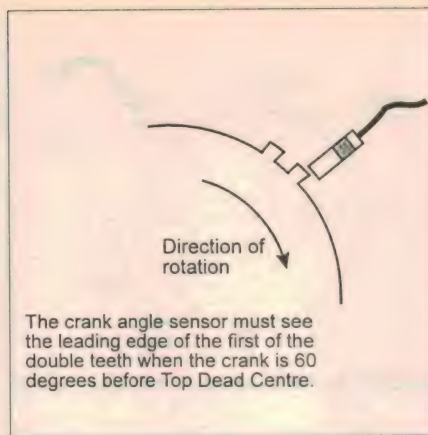
**/INJMAP:** Injection Map

- (decrease parameter value)
- 1 - Nearest injection Map point
  - 2 - Load band move 16 RPM points
  - 3 - Load band reset 16 RPM points
  - 4 - Injection scale adjust

**IGNMAP:** Ignition map

- (increase parameter value)
- 1 - Ignition map point
  - 2 - RPM band move 8 load points
  - 3 - RPM band reset 8 load points
  - 4 - Ignition offset adjust

This is only a basic description of the menu functions, because space does not allow a comprehensive explanation. But



**Fig.5: The first edge of the double teeth on the trigger disc must line up with the trigger sensor at 60 degrees BTDC.**

as can be seen from the information above the setup of the system is relatively self-explanatory once you get used to driving the hand controller.

There is a certain amount of expertise and equipment required to get maximum power and efficiency from the system, but it must also be remembered that memory cartridges are available for quite a few engines. So installation may well be as simple as fitting and wiring the system to the vehicle, followed by minor parameter setup changes.

But if a cartridge is not available, then you may have to run the vehicle on a chassis dynamometer and set the parameters according to the information gathered with an ignition scope and gas analyser.

### Version update

The latest version of the Wolf 3D has both software updates and wiring updates to make installation easier. The new software revisions include data logging for the following inputs: RPM, Load, Ignition timing, Injection time and Duty cycle, Throttle position, O2

sensor, Coolant temp sensor, Air temp sensor and battery voltage.

All of the devices listed log a minimum and maximum value and the value can be retrieved when requested. This is a powerful faultfinding tool when looking for intermittent faults. If there are any triggering errors these are also logged. MaxMap logs the maximum boost pressure and also the lowest vacuum reached.

The O2 sensor logging is a 128-location specialised data logging feature that tracks and averages the O2 sensor reading while the engine is running. It then stores and displays it when viewing any of the adjustment points on the fuel or ignition map. This makes it easier to tune the engine because if there are any 'holes' in the map, the tuner can inspect the relevant map points and see what the O2 reading (Air/fuel ratio) was at that point.

The new hardware also includes a built-in demux for the ignition; this was accomplished externally on the 'old' 3D unit. There are also LEDs to indicate ignition operation.

A new 'rotary' feature is included so that the standard electronic distributor (and two coils) can be used to reduce setup costs. Extra engine selection modes are also available. These include single cylinder two- and four-stroke, and two cylinder two- and four-stroke.

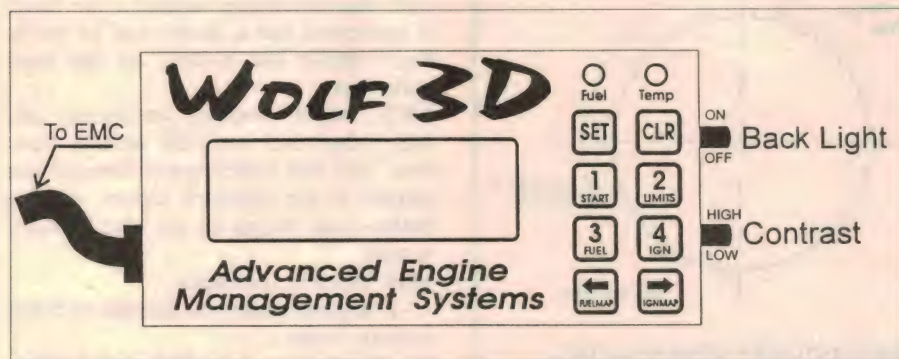
Other extras include the addition of a vertical bar graph on the main screen, showing the immediate value of the O2 sensor output. DIP switch 7 (Map protection) now prevents entry to menu 4 (Ign) as well as the INJ and IGN adjust menus. And there's now the ability to lock Idle injection in Map % load mode, for engines that have bad or weak vacuum signals.

As you can see the AEM engineers keep updating the unit so it is easier for the 'user' to install, tune and operate.

At the end of the fax from AEM, I found a very interesting fact — one that is very encouraging for future use. This is that closed-loop control was to be available from around March 1997.

Incidentally I haven't mentioned much about the injection control capabilities of the Wolf 3D. What I can say is that it has as much flexibility as the spark control. There are again a few modes available to ensure good efficiency, heaps of 'go', acceleration enrichment and great idle quality.

Well, that wraps it up for this month. I hope the second part of this discussion of the Wolf 3D gives you an indication of the job ahead, if you are going to either upgrade an existing engine management system or install a unit onto a carby/points vehicle. Until next time, bye. ♦



**Fig.6: The hand controller used with the Wolf 3D system, to feed in and check its running parameters. It features a friendly menu system, with eight buttons and an LCD panel.**



# NEW PLASTIC BATTERY HAS REAL POTENTIAL

Researchers at a US university have developed the first successful rechargeable battery made totally from plastic materials. The all-polymer battery can be manufactured in very thin sheet form, and has the potential to replace conventional batteries in many critical applications.

by GEOFF McNAMARA

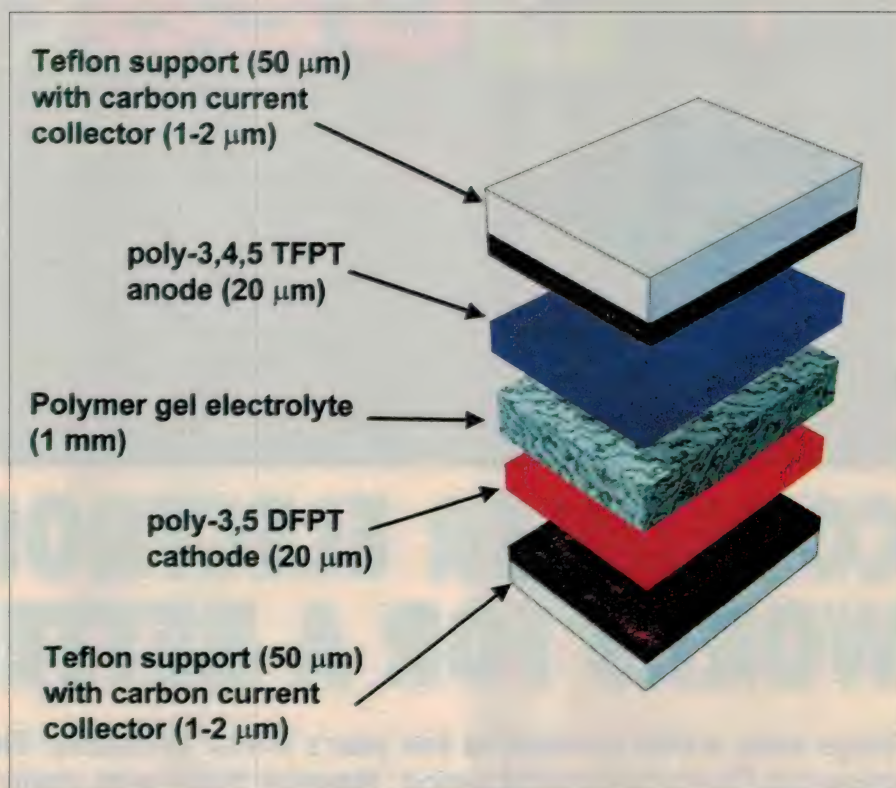
A team of researchers from Johns Hopkins University in the United States have created the world's first all-plastic battery. The battery — which uses only polymer components — is being heralded as a breakthrough, with the potential to replace conventional batteries used in appliances ranging from hearing aids to military satellites.

Researchers have been trying to develop the all-polymer battery for several years. Because they are light and can be moulded to any shape and size, they are particularly suitable for appliances where weight and space limitations are important, such as satellites.

Earlier achievements in plastic electronic components include the all-polymer transistor created by scientists at the Laboratoire des Matériaux Moléculaires in Thiais, France in 1994. This was the first transistor to use polymers for all of the components, including the electrodes, and had the advantage that it was made solely with printing techniques — so it didn't require high-vacuum or high-temperature conditions. In a similar development the Poly Plus Battery Company produces a lithium-polymer battery. These batteries are also remarkably thin and have many of the advantages of the all-polymer batteries.

Development of the all-polymer battery, however, has been hampered by the fact that most polymers lack the energy difference required to serve as electrodes. The breakthrough came when Johns Hopkins University materials science and engineering professors Theodore O. Poehler and Peter C. Searson created new polymers capable of storing and discharging enough electricity to make them comparable to conventional batteries. The new polymers are able to generate up to 2.5 volts, enough to compete with 3V lithium batteries currently widely used.

The research was commissioned by the Rome Laboratory, a US Air Force research and development centre in New York. Rome Laboratory specified



they were after a thin, light weight, all-plastic battery that could be used in military satellites and other instruments. The five year project resulted in a battery with a polymer anode and cathode, both 20 micrometres thick, mounted on 50um thick teflon substrates coated with a 1um thick carbon layer.

There are many advantages of the plastic battery in addition to its light weight and thinness. For example, being no thicker than a business card, it could be made in a large sheet that occupies an entire wall, wound up into a roll of similar size to a conventional battery, or fitted into the often limited space on board a satellite.

The battery can be recharged hundreds of times, does not leak and operates under a wide range of temperatures without significant performance degradation. Researchers at the Johns

Hopkins Applied Physics Laboratory are currently looking at ways of linking the batteries with a new solar cell charging system.

Manufacture of the batteries is said to be no more difficult than that for conventional batteries. At the same time, the all-plastic batteries lack the health and environmental hazards associated with the heavy metals in nickel-cadmium rechargeable batteries.

While the technology is still in its infancy, the researchers are now looking at ways of adapting the battery design into practical uses. The Johns Hopkins researchers have applied for a patent for the battery, which will be eventually be made available to private industry.

*(Geoff McNamara is a freelance science writer based in Sydney, and a frequent contributor to EA.) ♦*



## The 1997 Winter CES in Las Vegas:



# CONSUMER ELECTRONICS WORKS FOR A BETTER 1997

Things were a trifle subdued at this year's Winter Consumer Electronics Show, following a disappointing Christmas trading period. However there were plenty of new products on display, as evidence of the industry's determination to develop new consumer electronics areas in 1997.

by **PAUL SWART**

The global consumer electronics industry stumbled into Las Vegas this January, after one of the worst Christmas holiday seasons any of the 95,000 visitors cared to remember. Consumers had revolted against the industry's failure to deliver on a number of key promises, most notably digital video disc players (DVDs) which were supposed to captivate holiday shopping crowds at Christmas.

DVD shipments were delayed when the manufacturers of the devices could not reach agreement with Hollywood studios on protecting the software from illegal copying. When the two sides finally settled their differences in October, it was too late for Christmas sales.

Another holdout in the USA has been high-definition televisions, due to the US Federal Communications Commission which didn't announce the new US HDTV standard until December.

But although sales *were* disappointing in the fourth quarter, optimism prevailed at the Consumer Electronics Show — with DVDs, surround sound, and a host of new innovative gadgets leading the charge. The most commonly heard phrase at the show this year was 'digital convergence', which describes the merging of television, personal computer, telephone, Internet, and home entertainment technologies. Products that incorporate two or more of these converging disciplines go

by acronyms and names such as DVD, DSS, TV/PC, PCN, web-browsing TV, interactive cable, digital cameras, smart phones, wireless products and more — all with related ancillary products, accessories and support.

"Digital technology is exploding. The technology is now in place. It is providing a wave of new products and services", said James Meyer, executive vice president of Thomson Consumer Electronics.

Despite the lower-than-expected Christmas sales, the US market still managed to show a 4% overall gain in 1996 to US\$65 billion. Robert Borchardt, chairman of the Consumer Electronics Manufacturers Association (CEMA) said



consumer electronics sales in 1997 will grow to US\$70 billion in the United States, a 6% increase over 1996.

Industry executives hope for stronger than expected sales based on the slew of new products available to consumers, most notably DVDs — the first of which were expected to retail for between US\$600 and \$1000 when they hit store shelves in February. At the CES Sony, one of a dozen firms showing DVD movie players (which put a full-length movie on a standard-size compact disc), said its \$1000 DVP-S7000 system allows for both DVD and standard audio discs to be played on the machine. It also features three fast forward/reverse viewing speeds (2X, 10X, and 30X) and high-end audio capability.

CEMA president Gary Shapiro answered the volley fired last November by Intel's Andy Grove, who said PCs are competing directly with televisions in a "war for consumers' eyeballs". Shapiro said "there are enough eyeballs to go around, for the television and computer industries to benefit. But we must continue to create exciting and compelling products. HDTV and DVD are two such products."

"DVD and digital television should drive consumers back into the stores. While I do not expect DVD to be the sav-

iour for our industry, I anticipate that it will create some needed excitement and prompt consumers to upgrade other components such as their televisions, audio equipment and speakers", Borchardt said.

Much of the acceptance of DVDs will depend on how fast Hollywood studios will make movie titles available to consumers, and what cost premium they'll carry over traditional VHS tapes. Between 75 and 100 major titles are expected to be in stores by the middle of the year. By the end of 1998, virtually every movie title available on tape today should be for sale in DVD format as well.

Between 500,000 and one million DVD player units are expected to be sold in 1997, increasing to 10 million units per year in 2000. Stimulating DVD sales will be PC users, in addition to television consumers, as the new devices will enable PC users to incorporate the digital data on DVD discs into various multimedia applications.

### Hot products

In addition to DVDs, other hot products shown at CES included various video telephones, 3-D television visors, flat panel TVs and super-large TV displays with new levels of clarity and digital surround sound.

Many eyes also remain trained on Web



**The 'Listen Up' from Cupertino firm Audio Highway stores up to an hour's worth of text (such as e-mail messages) from a PC, and turns it into speech for the busy executive.**

access devices such as telephones, set-top boxes and cellular phones. So far, WEB TV systems from Sony and Philips have sold modestly, although consumers continue to look for 'killer applications'. Oracle, meanwhile, announced it has lined up Zenith and RCA to manufacture and market its Network Computer Internet system which also uses the TV as the display medium.

InfoGear of Redwood City in Silicon Valley has also launched the iPhone Internet telephone, a device that will retail for around US\$600 and allows users to 'dial' web sites — which subsequently pop up on the system's small LCD display.

Digital cameras remain a major source of optimism in the industry, as manufacturers hope tens of millions of home PC owners will make the conversion from film to digital pictures. The most important aspect of digital cameras displayed at CES was that they are becoming both better and dropping in price at the same time. Consumers will be able to purchase relatively powerful digital cameras this year for around \$200. At the high end, Olympus launched the D-300L, which offers a resolution of 1024 x 768 pixels. The US\$900 device stores up to 120 pictures.

Meanwhile, Toshiba's Computer System Division introduced the first DVD-based PC. The Infinia desktop computer features a DVD drive and is powered by Intel's new MMX Pentium processor.



**Wurlitzer displayed one of its updated replicas of the classic 1950s 'Elvis Presley' jukebox. Selling for \$12,000, the modern version holds up to 50 CDs and has 200W of amplification and speakers built in.**



# The '97 Winter CES

## New & innovative

Innovation is always a major attraction of CES. Among the more innovative products launched at this year's event were:

**SILENCE INDUCER:** Ever tried to keep up a conversation at a loud reception or in a bar, or listen to a movie in a noisy jet airplane? That is no longer a problem thanks to revolutionary 'anti-sound' technology from Noise Cancellation Technologies of Stamford (Connecticut). The company launched its NoiseBuster Extreme, a US\$70 headphone system that cancels out most background noise. The system produces a digital copy of the noise surrounding the user. The digitally created anti-sound signal and original signal, like two opposite waves in a pond, cancel each other out when they collide, leaving almost no background noise.

When the unit is connected to an audio-CD player or an airplane's sound system, it allows the user to enjoy the recordings or movie. It is also possible to have a conversation at normal speech volume in a crowded bar or party. The system allows the user to adjust the level of noise cancellation from eight to 15 decibels.

**REMOTE CONTROL IN THE CAR:** Germany's Blaupunkt launched an innovative remote control for several of its automobile CD/receiver lines. The unit hooks to the inside of the steering wheel, from which drivers can control the CD-receiver with their thumb or other fingers without their hands ever leaving the steering wheel.

**RADIO IN YOUR EAR:** American Technology of Poway (California) introduced what it claims to be the world's



**Cyberlink Mind Systems' headband has sensors which detect EEG signals and turn them into computer commands. With training, users can control many PC functions.**

smallest radio. The unit plugs into the ear like a small hearing aid. It has two volume settings and a scan button that will move from station to station. At around US\$30, the device may become a popular item among students trying to listen to their teacher with one ear and their favorite pop station in the other. And of course, dad may want to borrow the unit to enjoy the Big Game while sitting through a business meeting.

**JUKEBOX FEVER:** Consumers with more than the average disposable income and a taste for nostalgia, may not mind shelling out US\$12,000 for a replica 1952 Wurlitzer Elvis Presley jukebox. Only 35,000 of the special edi-

tion units will be manufactured. On a more reasonable level, a similar 1950s style 6-CD jukebox will retail for around US\$600.

**TOUCH-SCREEN DISPLAY:** Touch screens have never caught on in the market, as Hewlett-Packard found out in the mid-1980s when its first entry into the PC market bombed despite a touch-screen display that was revolutionary at the time. Some innovations, however, make it on the second or third try. That is what Keytec hopes is in store for its line of touch-screen panels which attach to the face of existing displays. Any Windows or Macintosh-operated software can be touch-controlled with the Keytec displays, which start at around US\$300 depending on the size of the display.

## Mind control

Remember how Clint Eastwood controlled the advanced Soviet fighter with his mind in the movie *Firefox*? That was Hollywood special effects, but the brain-activated PC mouse demonstrated by Cyberlink Mind Systems (CMSI) of Yellow Springs (Ohio) allows the user to similarly control his or her PC cursor on the computer display — pull down menus, execute commands, and even play musical instruments — using only the power of the mind.

The 'Cyberlink Actuated Tracker' (CAT) consists of a narrow headband with three embedded sensors centred on the forehead above the nose. The sensors detect minute electrical signals emanating from the forehead that result from subtle brain and muscle activity when operating a computer. The signals are generated when the user moves his eyes around the display, such as when moving the cursor from left to right.

The sensors transmit the signals to an amplifier unit the size of an external modem. After amplifying and filtering, signals are processed digitally into a so-called 'brainfingers'. By learning to control changes in the energy levels of these brainfingers, users are able to control the cursor, issue operating commands or control the PC's audio and video outputs. Eventually, some musically-inclined PC users may be able to play PC-based musical instruments using only their mind...

From CES demos of the system, it is obvious that it will take a first-time user a bit of practice before they get the hang of controlling the 'brainfin-



**The \$70 'Noise Buster Extreme' from Noise Cancellation Technologies delivers silence by cancelling ambient noise.**





**C-Phone's set-top box links a standard NTSC colour TV set to the phone line, and has an inbuilt camera to provide full colour videophone facilities.**

gers'. But almost anyone will have some immediate results. CMSI president Andrew Junker said most users will be able to perform a variety of functions within a few hours.

While it may not be the fastest way to work, the novelty of the technology is exceptional. At around US\$500, it will be a must-have for anyone seeking to impress friends, family or co-workers. On a more practical level, the device will make life a lot easier for many physically handicapped people.

The price includes both the headband, amplifier, installer software, and a bottle of 'CyberGel'. The latter is a specially formulated blend of Aloe Vera and Vitamins A, C, and E. It operates as a moisturizer on the forehead, creating a conductive film between the skin and sensors in the headband.

Junker said he expects the product to become available in the second half of 1997. The company is currently looking for distributors to carry the product.

## Videophones, flat TVs

Ever since AT&T first displayed one more than 30 years ago, picture telephones, along with flat panel TVs, remain two of the biggest unfulfilled consumer electronics promises. But at the CES a slew of companies, ranging from start-ups to international conglomerates, showed products suggesting that the wait may finally be over.

The most recent effort to bring picture phones into the consumer market was made around 1992, when AT&T and several other firms launched picture telephones using small B/W LCD dis-

plays built into the telephone set. But consumers didn't bite, just as they hadn't with previous attempts.

The new efforts look at least more promising at this point, as the systems are both affordable and feature colour images on a medium consumers are all too familiar with: the television.

Startup C-Phone of Wilmington (North Carolina) launched its C-Phone Home TV. The camera equipped set-top box hooks into a TV set on one side, and into a standard telephone outlet on the other. Based on the H-234 industry standard video conferencing code, and using a 33.6kb/s modem, the system produces video pictures at rates between 5 and 15 frames per second. It's built around an array of eight digital signal processors to handle the vast amount of compression and decompression computations. The system's remote control doubles as the telephone receiver. The C-Phone system will cost around US\$350 plus a monthly service charge of around \$20. All calls are carried over C-Phone's own long-distance carrier.

"C-Phone Home will finally and forever change the way people use telephones", said Daniel Flohr, chairman of C-Phone. "The system allows the caller and receiver to see each other on their C-Phone Home equipped TV sets, while they are connected to each other over their standard telephone lines".

"C-Phone Home brings together people



**Flat screen TFT-LCD displays have now reached 40" (101cm), as shown by this SVGA display on the Sharp stand.**



**American Technology's 'world's smallest radio' fits inside the ear, much like a hearing aid. The dangling wire is presumably the antenna.**

who live in different cities and countries via visual interaction that has until now been unavailable to the average person."

Competing with C-Phone will be Logicode Technology of Los Angeles. Although more expensive at US\$500, Logicode's set-top box does not require users to pay a monthly service fee and calls are made over any carrier. The system also allows for panning and zooming.

Another company that launched a similar H-234 standard based TV set-top box system is 8x8 Inc, whose ViaTV Phone provides telephone-quality audio and video for US\$499, also with no additional monthly costs. "Ever since the 1964 World's Fair, people have been dreaming of a video phone that will provide an element of the visual communication that people enjoy in a face-to-face conversation over coffee or across a table", explained Joe Parkinson, president and CEO of 8x8. "But this dream has been out of reach for the average consumer, who doesn't have the money, time or technical skill to take advantage of traditional and computer-based video conferencing".

The ViaTV Phone works with a television and a touch-tone telephone to provide a complete video phone. About the size of a soft-bound book, it contains 8x8's powerful Video Communications Processor (VCP) chip, a digital video camera and a high-performance modem. After connecting the system to the TV and standard touchtone telephone, users simply call another person with a ViaTV Phone, press a button to start the video, and have a full, two-way video conversation. ♦



**New very low cost 'notebook' PC:**

# **BROTHER'S 'SUPER POWERNOTE' PORTABLE**

With its new 'Super PowerNote' portable, Brother Industries has shrewdly avoided the prevailing trend towards adding umpteen rarely-used 'bells and whistles', and inevitably moving upmarket. Instead, it has produced a compact and very practical unit, offering just about all of the features that many of us are really likely to need 'on the road' — and at a price far below any of its competitors.

**by JIM ROWE**

Why is it that just about all of the laptop/notebook portable PC makers seem to have assumed we all want these machines to be as complex and multi-functional as a modern 'multimedia' desktop PC? Do they *really* think we need to be able to look at CD-ROM video and listen to stereo WAV files on a plane or train, or design a complex PC board in a distant hotel room? Of course not.

Like the rest of the computer industry, they've become trapped on the marketing treadmill, where each of your new models simply has to have more 'bells and whistles' than those of your competitors — regardless of whether the consumers/users really need those bells and whistles, or are ever likely to use them. So the latest laptops and notebooks have inevitably *had* to have a fast Pentium processor, a whopping great full-colour active-matrix LCD screen with backlighting, a fast 2GB or better hard disk, 8MB or more of RAM, a 6X or better CD-ROM drive, a built in 33kb/s modem and so on...

All of which means, of course, that the prices of these latest portables start at about \$2600, and rise rapidly. In fact their prices are significantly higher than a desktop machine with the same capabilities — presumably because of the greater difficulty of cramming all of those components into a tiny case, and at the same time achieving an acceptable level of reliability and battery life.

Talking of battery life, many of these new notebook models run for only a couple of hours on a single charge, thanks to the power drain of their many subsystems and their LCD backlighting.

But in reality, when most of us are 'on the road', we don't really *need* access to a PC with all of the features and functions of our office machine. In most cases, all we need is a basic word processor, perhaps a

few spreadsheets, a calculator and a few 'organiser' facilities like a scheduler, address book, calendar and clock. We'd also like it to be compact, light, have as long a battery life as possible, and preferably cost a heck of a lot less than those 'overkill' models.

An idle dream? No, because Brother Industries has recently come out with a machine which meets this specification almost exactly.

The new Brother 'Super PowerNote' PN-8500MDS is compact (285 x 246 x

48mm) and surprisingly light (1.9kg without battery). It has a compact but very practical (and quiet) 59-key 'Perfectype' keyboard, with substantially full size keys, and a choice of either standard ASCII or US character sets.

The LCD display screen is only monochrome (black on light green), has no backlighting, and measures only 213 x 92mm (232mm diagonal). However it has a contrast control and provides quite readable display of 22 lines of 80 characters, or character-based graphics. Lower-case





characters with 'descenders' (like y, p, g and so on) are compressed vertically because of the limited screen resolution, but otherwise the display is entirely practical for word processing, spreadsheet work and the other functions. Clearly you can't work in the dark, or in really poor ambient light conditions, but that's hardly a serious limitation.

What applications are there? Well, there's a fairly easy to use word processor with built-in spelling checker, a spreadsheet (very similar to the DOS version of Lotus 1-2-3), a simple 'addressbook' database, a simple communications terminal program, a 'line by line' typewriter program for printing things like address labels (when the machine is hooked up to a printer — more about this later), plus many of the functions found on one of those 'pocket organisers': a calculator, a scheduler-calendar, a clock with world time and alarm functions, and a 'things to do' list. There's also a built-in online help facility, which generally provides enough info to mean that you can leave the Brother's manual back in the office.

The machine has a standard 3.5" floppy drive (more about this shortly), but no hard disk at all. Nor is there either a DOS, in the normal sense of the term, or *any* version of the ubiquitous Windows (Bill Gates, eat your heart out!). And when it comes to user memory, we're not talking about megabytes here but kilobytes: about 63 of them. All of which might sound bewilderingly small and impractical to those raised in the Windows era with its ever-expanding software, memory and disk sizes, but of course there's a simple explanation — and one that makes a lot of sense, to anyone who's been around computers for a while.

It's simple: what Brother has done is put all of the 'system' and 'application' software into ROMs, as firmware. This avoids the need for a hard disk, as the firmware is 'always there' in ROM. And because it *runs* in ROM, you don't need a huge amount of RAM either — just enough for the user's file(s) and a scratchpad/stack.

So that apparently modest 63KB is in fact all available for current user data, making the machine much more practical than you might think. For example you can work on individual word processor files up to 32KB in length (or about sixteen A4 pages of solid text (or over twice the length of this review). You can also have spreadsheet files up to 15KB in length, addressbook files up to 12KB in length and so on. All of which should be more than enough for most of us when we're away from the



***It mightn't have Windows 95, gigabytes of hard disk or a huge colour LCD with backlighting, but the SuperNote is still quite capable of doing what most people really need 'on the road' — at a fraction of the price. The menu screens are still quite friendly, as you can see, and it can also run for up to eight hours on a charged battery.***

office (and probably more than many people need even in the office).

Because this user file material is in RAM, which has its own lithium backup battery, it's protected even when the power is turned off and the main NiCad battery pack is either flat or removed. Which means it's accessible as soon as you turn the machine on; there's no waiting while it's loaded from the hard disk.

But of course you can also save a copy of your current files on floppy disk, as a backup mechanism. The floppy disk also provides one of the two ways that you can transfer files to a DOS-based PC — the other being to transfer them via the RS-232C serial port, and a suitable cable. Although the Brother doesn't seem to use DOS itself, the floppy format is fully DOS compatible and you can use either 1.4MB or 720KB disks formatted by a PC (which is all that really matters, of course).

Once you get the files into your PC, there's a conversion program called CONVERT.EXE (supplied) which allows you to convert word processor files to and from a wide variety of standard WP programs (most popular packages, including Word for Macintosh and IBM DisplayWrite), and another called SCONVERT.EXE which converts the Brother's spreadsheet files into or from Lotus 1-2-3 format.

As I mentioned earlier, the Super

PowerNote not only has an inbuilt RS-232C serial port, but a Centronics-type parallel printer port as well. And along with these hardware facilities it has a set of inbuilt printer drivers (again, in firmware), which allow you to print out any of your files to a variety of common printers — via either the parallel or serial ports. Compatible printers include Brother's own inkjet, laser and dot-matrix models, HP inkjets and lasers, Epson inkjets and dot-matrix models, IBM 9-pin and 24-pin Printers, the Canon BJ inkjet and a generic 'TTY'.

So as you can see, the basic capabilities of the Super PowerNote are really quite respectable — despite its apparently very modest specs and lack of impressive numbers when it comes to megahertz and megabytes. (Incidentally, Brother doesn't even specify what processor is used, or the speed it runs at. I suspect it might well be an 8-bit chip — not that it really matters...)

Before I forget, the Super PowerNote comes as standard with a plugpack type mains power unit (9V/1A DC). The rechargeable NiCad battery pack is an optional extra, as is a carrying case. But the machine typically runs for up to *eight hours* from a charged battery pack. This is considerably longer than just about any other notebook machine, and shows clearly the 'upside' of *not* having a hard disk or backlit LCD.



## Brother's 'Super Powernote' Portable

### Ease of use

But how about its ease of use, without the wonders of that famous Windows GUI? Does using the Super PowerNote involve a step backward in time, to the unfriendly world of arcane command-line mnemonics? No, not really. Brother's designers seem to have done a pretty good job of providing their own GUI-type 'greeting' and 'main menu' screens (see photo), plus various others whenever they're needed. In some cases these clearly use character-based graphics, and sometimes the procedure to achieve a certain operation seems not entirely intuitive; but on the whole it's all quite friendly and easy to drive.

I've deliberately written this review on the Super PowerNote, for example, to try it out properly. While doing so I found myself referring to the Owner's Manual only a few times, and mainly to check on the unit's exact specs and capabilities. Other than that, I only needed it to find out how to do 'rare' operations like changing the WP margins and setting up/editing an 'abbreviated phrases' file.

In transferring WP files like this review over into my office PC, I confess

I did find the CONVERT.EXE program a bit clunky and counter-intuitive, especially at first. It really has to be set up in a particular order, and gives you fairly terse error messages if you don't. But once you get used to its correct procedure, it's not too bad.

By the way, I accidentally discovered one little 'Achilles Heel' of the Super PowerNote, while I was experimenting with file transfers back and forth between it and the PC. By mistake I converted an ASCII text file over into the Brother's format, but with CONVERT.EXE still set to convert from Wordstar format. When I fed the resulting file back into the PowerNote, it would completely reset and wipe its memory clean whenever you tried to open the file in the WP — suddenly it would know nothing about files previously in memory, and had 'transported' itself back to New York city, on the morning of January 1, 1996!

Needless to say I didn't make that mistake again. Mind you, in normal use you'd very rarely transfer WP files back into the Brother from a PC — let alone make this particular mistake...

The only other little peculiarity I've

found, about the PowerNote's WP program, is that sometimes it seems to get itself in a bind at the end of a line. Somehow its auto word-wrap seems to trip itself up, beeping at you if you try typing in any more characters. The only way to fix it is to backtrack to the last word typed, and join your next word onto it — forcing the program to wrap around the lot. After this you can insert the missing space, and proceed as before. It sounds messy, and you really shouldn't have to do it, but (a) it doesn't happen very often, and (b) when it does, it's no great hassle once you've done it a couple of times...

### The bottom line

So what's my final verdict on the Brother Super PowerNote? Frankly, I found it a very practical little machine. For those who, like me, *don't* want to take a full-scale 'all singing, all dancing' multimedia monster on their travels, it's fine. It's quite capable of letting me do everything I want: some basic word processing, firing up and updating the odd spreadsheet, storing a list of contact names and addresses, perhaps calling up a computer BBS (or CompuServe, if I had an account) and so on.

In fact I suspect that if you team up the PowerNote with a suitable printer, it will do everything that many people really do with a PC — despite what most computer sales people might suggest. And for a heck of a lot less money, as it happens.

And this brings us to the crux of the matter, with the Brother Super PowerNote: the bottom line. The fact is that its Australian RRP is — wait for it — only \$699. That's for the basic unit, with mains power pack, User's Manual, lithium cell for memory back-up, and a 3.5" floppy with the PC conversion software, etc. The NiCad battery pack is a further \$99, and the carry case a further \$79.

So even with both optional extras, the total RRP is still only \$877, or only around a THIRD of the price of the cheapest conventional notebook PC. It's hard to argue with *that* logic, isn't it?

I'm so impressed, I've decided to buy one. Until now there was simply no way I was going to invest in a full-scale notebook, for the few times I ever need a machine 'on the road'. But the Brother clearly provides all I really need on such occasions, and at a price I can justify. QED!

The review machine came from Brother Industries (Aust.) Pty Ltd, of 7 Khartoum Road, North Ryde 2113; phone (02) 9887 4344, or fax (02) 9888 9707. However Brother also has offices in most states. ♦

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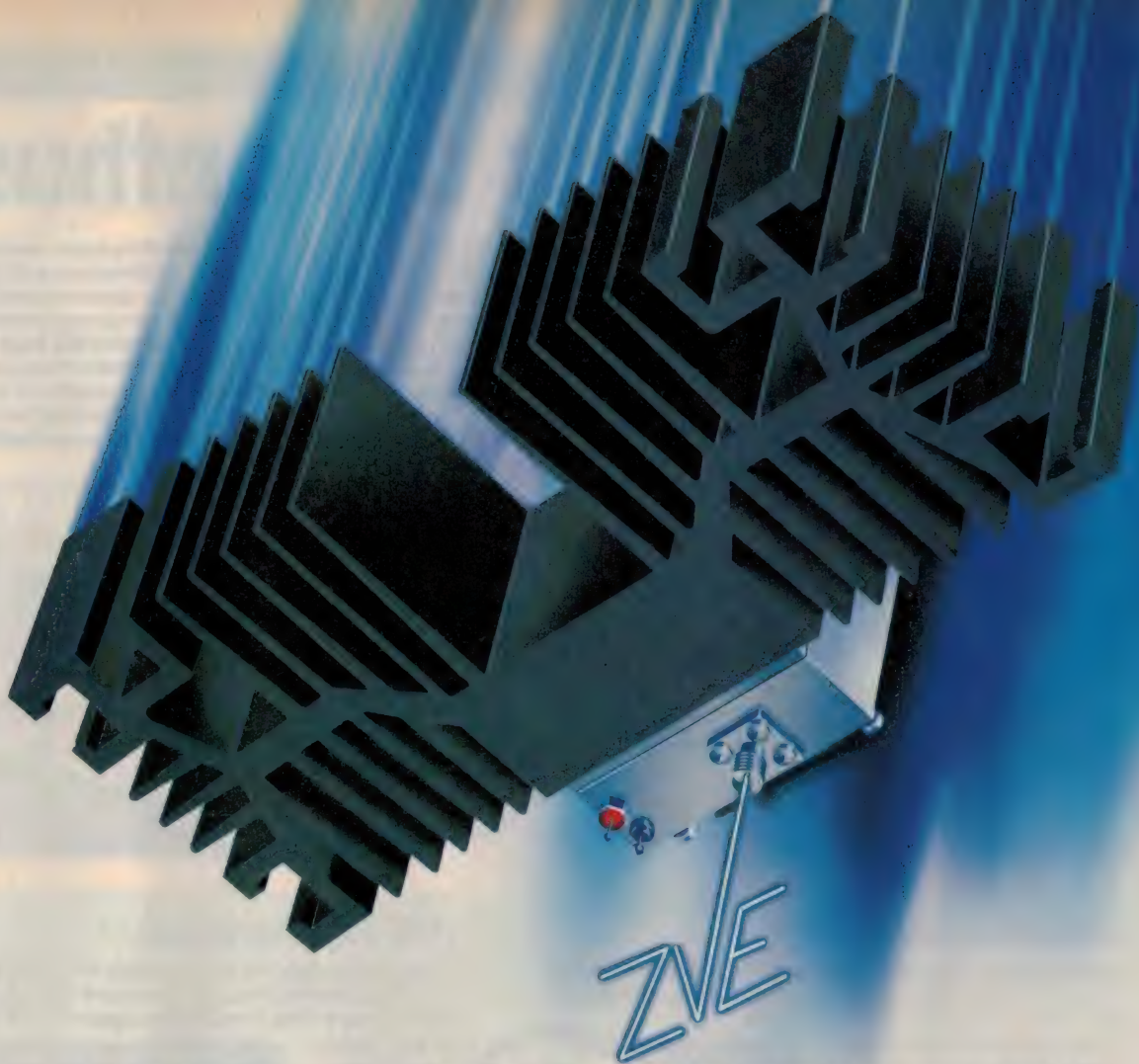
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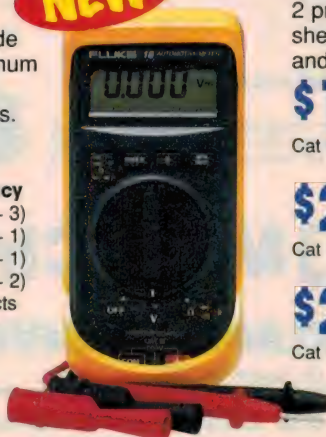
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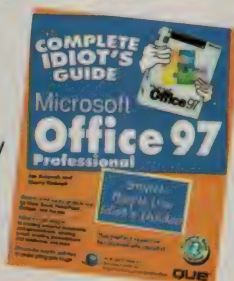
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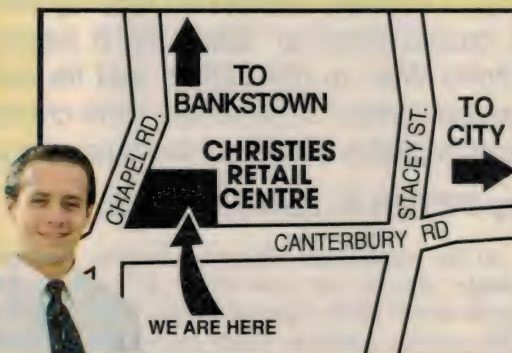
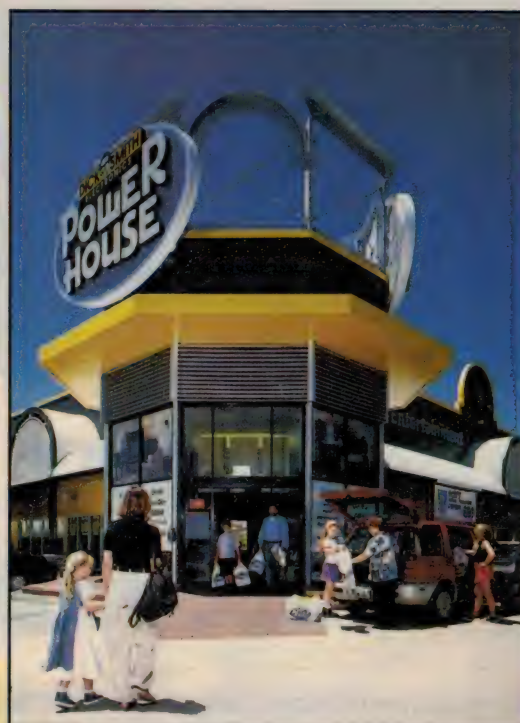
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## THE 'GREAT SECRET' OF THE SECOND WORLD WAR - 1

Ever since humans began communicating, it seems, there's been a need to encypher some messages so they couldn't be read by those other than the intended recipients. But often others have a crucial need to 'crack' such secret messages — as happened in Britain during the Second World War. In this article and its sequel, Peter Jensen explains how cyphering works and the codebreakers of Bletchley Park cracked Germany's code system based on the Enigma machine, and probably changed the outcome of that War.

by **PETER R. JENSEN, VK2AQJ**

At the present time, there can be few people who are not now aware of the 'great secret' of the Second World War. This was the extent to which the Allied (British and American) intelligence services were able to read the encoded messages of the Axis (Germans and Japanese). So sensitive was this secret that public exposure of it did not occur for nearly 20 years after 1945. Even at that stage, the

revelations were at first rather obscure, one of the first appearing in a book written by a Polish author.

Later the subject was more clearly revealed, although still rather obliquely, in the notable book by Kahn entitled, *The Codebreakers*. It was not until 1974, with the publication of *Ultra Secret* by F.W. Winterbotham, that a popular and readable exposition of the activities of

the British in reading German cyphers finally became available.

### **Bletchley Park**

As the stormclouds of war gathered over Europe in the late 1930s the British Government, realizing that as had occurred in the First World War 'the battle of the cyphers' was likely to be crucial, set about finding a safer base for



the codebreakers than had been available in that earlier conflict. Between 1914 and 1918, British Naval Intelligence had located its codebreaking group in Room 40 of the Old Admiralty building in central London — usually referred to as '40 OB'.

With the development of air power and the heavy bomber in the period before 1939, it was anticipated that aerial bombing was likely to be a very serious problem. As the Blitz was to demonstrate, this was a well founded concern. With this anticipated threat in mind, it was considered that central London was inevitably a potential target for the bombers. Accordingly the Government commenced a search for alternative locations for sensitive and vulnerable activities such as codebreaking, well away from London.

For a new base for the cypher personnel, ultimately an ideal place was found, strategically located on a line joining the University towns of Oxford and Cambridge and on the main rail line north from London. This was a mansion close to the small town of Bletchley.

The large late Victorian mansion known as Bletchley Park that was located at the edge of the small town had been built by the wealthy philanthropist, Sir Herbert Leon. Following his death in 1926, his wife continued to live on the estate until her own demise in 1937. Following this event, the property had been sold to a group of businessmen led by Captain H. Faulkner. These developers had purchased the property with the intention of converting the house and grounds into a new housing estate.

The intervention of the Foreign Office and what appears to have been a compulsory purchase of the premises, brought an abrupt halt to these plans; but not to the building activity on the estate. On the contrary, over the next five years the site was to be a hive of activity as the many structures that were required to house the ultimate population of the grounds were progressively erected. This influx of personnel who were to be stationed at Bletchley Park and employed in the work of breaking the German codes was ultimately to be numbered in thousands.

By the end of the war in 1945, the large Victorian mansion was surrounded by a mass of light-framed army huts and other more substantial buildings and these can be seen in the accompanying layout plan. In the huts the teams of decyphers and other specialists, such as linguists, were accommodated. For these dedicated people, constrained to work in such such thin walled and light-insulated buildings, it must have been

a most uncomfortable existence, particularly during the long, cold and overcast winter days of England at war.

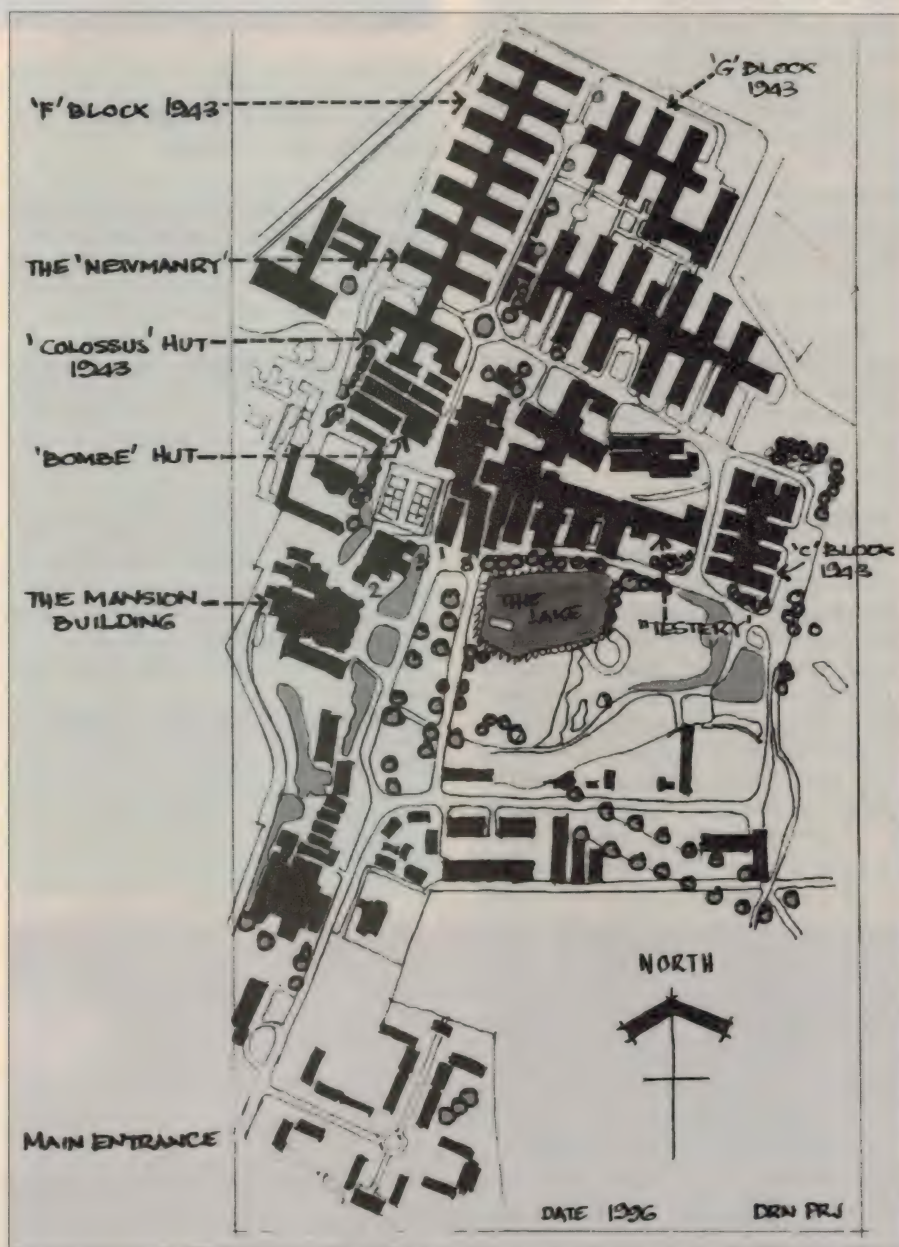
## Boniface and Ultra

The decyphered material produced by this highly secret and isolated group of academics and experts came to be what Churchill called his 'Most secret source'. For reasons of security the material produced at Bletchley Park was to be distributed to a very small and select group of recipients, initially under the cover name 'Boniface'. Later this was changed to the name that many would now recognize: 'Ultra'.

The book that was published by

Winterbotham in 1974 did much to explain how the intelligence material gathered by the codebreakers of Bletchley Park was used and disseminated as one of the weapons required to defeat the Nazis. However much of the information relating to the precise means of decyphering the codes only came to light after 1980. In particular, the relatively recent re-opening of the Bletchley Park complex as a museum and display has been of particular importance in bringing the work of the war years to the attention of the public at large.

Since 1992, a dedicated group of enthusiasts and former members of the secret band of specialists who were



A sketch showing the layout of the Bletchley Park complex as it was in 1945, as made by the author late last year. By the end of 1945, thousands of people were employed in decyphering the German military's communications.



## Bletchley Park

employed at Bletchley Park during the Second World War, have expended enormous efforts to establish a fascinating museum for the visitor and tourist.

Many secrets have now come to light with the publication of the books referred to earlier and with the opening of Bletchley Park itself. However it is the contribution of Poland and its extraordinary team of young code breakers that is perhaps the most poignant. Their attack on the secrets of the German codes had begun prior to 1930 and had achieved a significant level of success. This was in spite of the introduction of machine generated codes, which initially appeared to be incapable of being decyphered.

As the prelude to the Second World War, the Nazi forces were assembled on the border of Germany and Poland and the threat of invasion was all too clear. Realizing the value of the work that had been done up until that time, the Polish cypher bureau decided to turn over its resources to the British and the French counterpart organizations.

Seen with the perspective of 1997, there can be little doubt that this generous decision was to have the greatest possible benefits for the Allied war effort and played a most significant part in the ultimate outcome of the hostilities.

### Cyphering background

Since man first discovered the means to convey a message by writing, there have been occasions when secrecy was needed and from the earliest times some form of coding was employed. An early example of coding was used by the Roman General Julius Caesar, involving the substitution of each letter in the alphabet with another letter spaced away a uniform number of spaces: For example 'A' might be given as 'C' (two letters away) and 'C' would be given as 'E'. The code that resulted would be considered quite trivial and



*One of the original 'huts' at Bletchley, as photographed by the author recently. In 1945 the hut probably looked much like the photo at upper right on the opposite page, and was a hive of activity.*

### Text of the Zimmerman Telegram — 1917

We intend to begin on the first of February unrestricted submarine warfare. We shall endeavour in spite of this to keep the United States of America neutral. In the event of this not succeeding, we make Mexico a proposal of alliance on the following basis:

Make war together, make peace together, generous financial support and an understanding on our part that Mexico is to reconquer the lost territory in Texas, New Mexico and Arizona. The settlement in detail is left to you.

You will inform the President (of Mexico) of the above most secretly, as soon as the outbreak of war with the United States of America is certain and add the suggestion that he should, on his own initiative, invite Japan to immediate adherence and at the same time mediate between Japan and ourselves.

Please call the President's attention to the fact that the ruthless employment of our submarines now offers the prospect of compelling England in a few months to make peace.

Zimmerman.

even a child of today would find it quite easy to decypher.

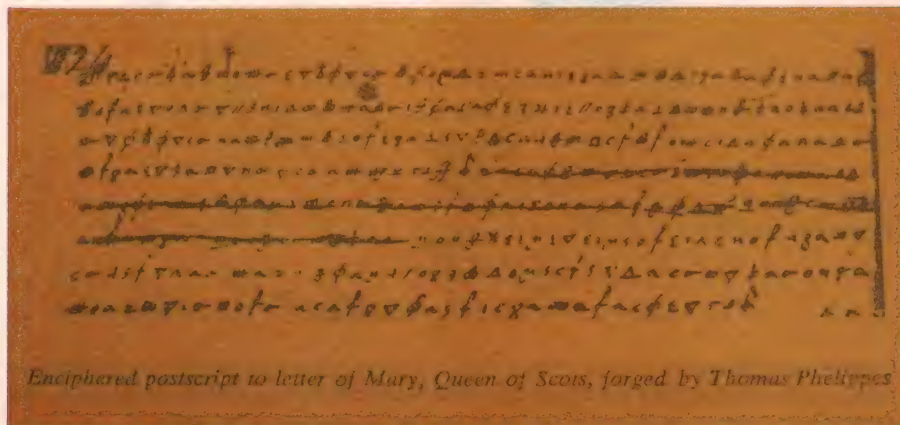
In Elizabethan times, an exchange of cyphered letters between Mary Queen of Scots and her supporters led ultimately to her execution for high treason. What the secret writing revealed to the renowned spymaster Sir Francis Walsingham was her ambition to supplant her great rival, Queen Elizabeth I.

Worse was that the decoded letters revealed her knowledge and support of the conspirators in their seeking of assistance from the great enemy, Spain. However what finally sealed the tragic Queen's death warrant and sent her to the Executioner's block was a subtle and damning paragraph that was added as a forged postscript to one of her letters. This cunning piece of Elizabethan 'disinformation' was carried out by Thomas Phelippes, the principal Cryptanalyst employed by Sir Francis Walsingham.

One can also see in this episode a lesson for those bent on sending secret communications. This is that for every clever cypherer and complex cypher used, there is frequently someone or something capable of revealing what was intended to be hidden.

At the outbreak of the First World War, having dredged up and cut Germany's undersea telegraph cable links, Britain was able to intercept the Kaiser's Naval

*The encyphered postscript forged and added to a letter from Mary Queen of Scots, by Sir Francis Walsingham's cryptanalyst Thomas Phelippes. It sealed her fate — an early example of effective 'disinformation'.*







*At left is a view of the Old Admiralty building in central London, where British Intelligence began operations during World War 1. Above is one of the Bletchley Park huts in 1945.*

radio communication most effectively. The group responsible for this successful penetration of the German wireless traffic was located in Room 40, in the Old Admiralty building.

During the war years this organization became more and more skilful at intercepting the enemy traffic. In 1917 the receipt and subsequent decoding of a telegram to the German Ambassador in the United States from Herr Zimmerman was to result in America entering the war and ultimately in the defeat of the German army. A reading of this document reveals why it received such an explosive and indignant response when its text was revealed to the citizens of the United States of America. (See box)

During the first months of the Second World War, knowledge of the contents of German codes and in particular Hitler's most secret orders, allowed British troops to be spirited away from the disastrous shores of Dunkirk, allowing the nucleus of a new British army to be saved. Soon after, in the Battle of Britain fought in the air over southern England, knowledge of the German intentions carried in their cyphered radio messages allowed the Royal Air Force to conserve its resources and ultimately triumph over a large and

potentially overwhelming opponent.

Later in that same conflict, the Americans were presented with reasonably clear indications of Japanese intentions to attack the naval base in Hawaii, Pearl Harbour, extracted from encyphered messages. Despite this, the failure to send the information to the Garrison and Naval Commanders in sufficient time resulted in a major disaster for the American Navy. The surprise raid launched by the Japanese air fleet dealt a shattering blow to America's Naval fleet lying unprepared below. Complete disaster was only averted by the fortunate absence of American aircraft carriers which had put out to sea a few days previously.

Later the Americans were to inflict a savage retribution upon the architect of this successful Japanese assault, when Admiral Yamamoto was ambushed in mid-air by long range American aircraft off the coast of Borneo. Yamamoto's plane was shot out of the sky and the Admiral was to die never knowing that it was the penetration of supposedly 'secure' Japanese cyphers that had enabled the action to occur and to seal his fate.

## Cyphering techniques

When one looks at the development of

cyphering over many years, it quickly becomes apparent that those intent on hiding the meaning of messages have employed progressively more and more complex means of hiding the true meaning of the individual letters used in composing the messages that were to be sent. This has usually been related to the creation of a cypher 'key', or sequence of changes to the meaning of individual letters that repeats or recurs over a progressively longer and longer period as increased security was sought to be achieved.

Those who have been involved in breaking the cyphers have turned more and more to mathematical and machine-based methods, to cope with the increasing level of complexity and to assist them in understanding what the cypher texts have hidden.

What the mathematically expert decyphers ultimately came to realize was that, where the means of jumbling up the letters to confuse the message was based upon anything that involved a repetition, if there was sufficient cyphertext to work with then ultimately it would be possible to use the repetition as a means to unlock the underlying message.

*Continued on page 93*

## The 'One-time Pad' system

Beyond even the astronomically huge repetition rates of the machine cyphers used by the Germans and more recent systems such as PGP, lies the ultimate secure system known as the 'One-time Pad'.

In this system, random arrays of numbers printed on pads of paper (one-time pads) are used as an encyphering key and added to the letters in the message to be encyphered, in a predetermined and systematic manner. For this to be possible, the letters of the intended message are first converted to a numerical value. When the text of a message is

treated in this manner, the encyphered letters which result have a randomness which derives directly from the random array of numbers in the one-time pad. The device, as the name would suggest, is used once only and then destroyed.

At the receiving end, by subtracting the same array of random numbers (contained in a duplicate copy of the one-time pad) from the letters in the encyphered message, it is possible for the original message to be recovered. This recovery is made with the assurance that the message cannot be read, in the meanwhile, by any unwelcome third party.

Unfortunately, while the one-time pad sys-

tem is totally secure and unbreakable, it fails in practice for administrative reasons.

During the two world wars, the need to use radio transmissions, on the one hand, and the sheer volume of message passing that occurred, on the other, made the use of such a system totally impracticable. It was in an endeavour to combat this problem of workload that in the 1920s the Germans turned their attention to the use of machines which could generate extremely long cypher keys with a very infrequent repetition rate, as a means of solving the problem of providing the army, airforce and navy with a secure method of message passing in the heat of a rapidly moving battle.



# RADIO-ELECTRONIC COMBAT AND ELECTRONIC WARFARE - 1

The success or otherwise of modern military operations is now largely dependent upon the use of communications, computers and electronics. If one can disrupt the enemy's control over his electronics systems by interfering with his use of the electromagnetic spectrum, one also disrupts control of his weapons systems and personnel. Nowhere has this been demonstrated more forcibly than during the Gulf War, when Iraq's military might was blunted — not just by firepower but by the use of sophisticated electronic systems operated by United Nations forces. This first article of a two-part series deals with the background and some basic concepts of electronic warfare.

by **JOHN BELL** B.E., M.Eng., F.I.E. Aust, F.I.E.E.

However abhorrent, wars in some shape or form have played a major role in the shaping of human history. Armies and fleets have sought to expand or defend territory for well over 2000 years, before modern weapons such as aircraft and missiles were added to their armouries.

Battles of old were relatively crude affairs, largely involving organised massed man-to-man combat with simple weapons and strategies. Today we have awesome weapons of mass destruction, with adversaries often

well separated from each other and Commanders perhaps further away. Radio, electronics and information technology are now all an integral part of this new style of warfare.

Although the battlefield has now changed, the essential ingredients for success remain the same. Military commanders, given adequate resources, have always needed the essential ingredients of what is now known as 'Command, Control, Communications and Intelligence' (often abbreviated to 'C<sup>3</sup>I') to max-

imise the effectiveness of their forces.

Commanders, for instance, need a command structure to control their forces and, in order for this to operate effectively, reliable communication systems and intelligence are required. Where these break down, disaster is almost inevitable. The immortal 'Charge of the 600' at Balaclava during the Crimean War is a good example of when all four failed.

An aftermath of the Industrial Revolution was the introduction of new weapons systems of mass destruction, which wreaked havoc during the Great War of 1914-18. Developments in electronics and radio communications prior to World War II inevitably saw their introduction into warfare and weapons systems; radar and aircraft navigation systems are well known examples.

Subsequent advances in electronics, particularly in semiconductor technology, have seen the introduction of electronic control of battlefield systems and the introduction of the digital computer. This last addition has led to the adoption of the acronym 'C<sup>3</sup>I' (standing for Command, Control, Communications, Computers and Intelligence) by some Defence personnel. It is these features which allow modern day Commanders to function, often situated far from the battles they might control.

## Electronic Warfare

Many of the weapons systems of today rely on the use of the electromagnetic spectrum for their operation. Radar systems are a good example, as they can be used in defensive, attack or other roles. Clearly, therefore, if one side loses control of even part of the relevant electromagnetic spectrum, then it



*An Australian developed experimental command centre. Such centres allow senior military commanders to make decisions based on information from many sources, and also to disseminate the decisions quickly, accurately and securely. (Courtesy Australian Department of Defence)*



is at a serious disadvantage.

Without communications, the ability to command, control and gather intelligence may be lost and weapons systems which are reliant on the use of radar, for instance, may be rendered impotent. Hence, in a combat situation both sides will try to exploit weaknesses in their enemy's use of the electromagnetic spectrum, whilst trying to protect their own. This has become known as 'electronic warfare'.

The origins of electronic warfare may be traced back to the America's Cup Race in 1901, when in the absence of radio broadcasting, newspapers would be the first to announce the winner of the race between the British and American yachts. Using the Morse code and spark transmitters, reporters with the accompanying flotilla planned to relay information on both yachts' progress.

Unbeknown to the official reporters, an enterprising engineer from another organisation made up his own code of signals and, by using a more powerful transmitter, then proceeded to jam his competitors' signals by the simple expedient of holding down his key. It was probably the longest Morse 'dash' in history. Presumably one newspaper chain made an immense profit that day, as their papers hit the streets first!

A standard definition of electronic warfare (EW) is 'Military action to prevent or reduce the enemy's use of the electromagnetic spectrum, and action which retains the friendly use of the spectrum'. Although in general use, the term *electronic warfare* is now somewhat of a misnomer due to the impact of new, more sophisticated systems of surveillance, communication and computers. EW is now being increasingly seen as an integral part of Radio Electronic Combat, or Information Warfare.

Today Radio Electronic Combat, often called Electronic Combat, is the essential system which military commanders use in their decision-making processes, as well as to control their forces. Nevertheless EW is still regarded as the application of techniques which seeks to disrupt an opponent's communications and weapons systems as well as protecting one's own. In a very narrow sense, it is, in itself, bloodless — although the results can be catastrophic for the loser.

The requirements of electronic warfare are a major driving force behind many developments in electronics, computing, communication and associated systems. Encompassing a frequency range from DC to light and

TABLE 1: Countermeasures

System	Countermeasure used	Comments
Passive jamming	Chaff	Clouds of chaff obliterate the target
Active jamming	Wide band or spot jamming	Target cannot be positively acquired though radar is aware that hostile targets may be present
Deception jamming	False or misleading radar returns are generated	The hostile tracking believes the target is at a different position in space
Cover jamming	Seemingly innocuous signals are beamed into opponent's radar	Operators may not realise that jamming is taking place
Decoys	A more attractive target is generated using flares or electronic devices	The hostile system is seduced away from its intended target
Communications jamming (COMJAM)	Noise or false signals are beamed at the enemy's communication network	Generally applied in the HF band in a battlefield situation

Table 1: Non-destructive or 'soft kill' ways of dealing with hostile tracking and communications systems.

employing some of the most sophisticated systems known to mankind, the principles and practice of electronic warfare are relatively unknown to all but a few in the high-tech industries and military personnel.

This specialised subject continues to challenge some of the best scientific and technical minds of today. In this series of two articles the author will explain the rudiments of electronic warfare, which will enable interested readers to gain an insight into a fascinating and continuing battle of wits between opposing military forces.

## Definitions

Prior to World War II, radar as well as new military navigation and communications systems had been developed in several countries. It was soon demonstrated that radar and the new radio communication systems could be jammed, or 'spoofed' in some way. Interference with the enemy's electronic radar and communications systems became known as Electronic Counter Measures or ECMs, and the protection of such equipment against enemy interference as Electronic Counter Countermeasures or ECCMs.

Gathering data on enemy systems is called Electronic Support Measures or

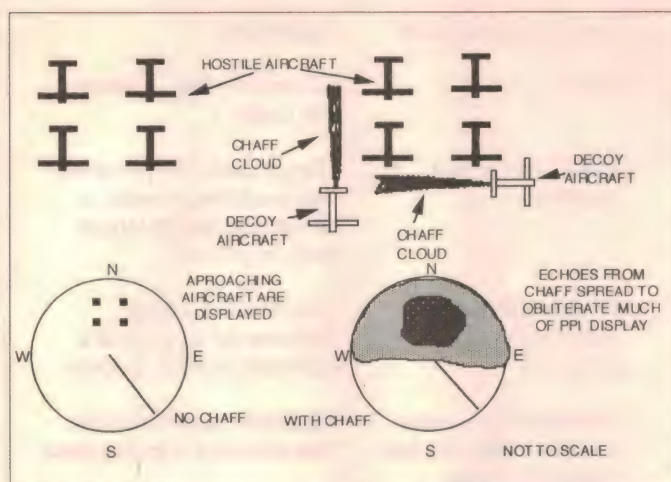
ESMs. Recent years have seen Electronic Countermeasures also called Electronic Attack (EA), Electronic Counter Countermeasures called Electronic Protection (EP) and Electronic Support Measures called Electronic Support (ES). These three facets are still the basis of modern Electronic Warfare.

Before being able to deal efficiently with a threat posed by the enemy's use of some part of the electromagnetic spectrum, one must know as much about the threat as possible. It's a matter of 'know thy enemy' or perish. So there we observe the EW cycle: a new threat emerges, ESMs are used to determine its characteristics, ECMs are developed to counter it and on the other side ECCMs emerge to nullify the countermeasures. The cycle then repeats itself...

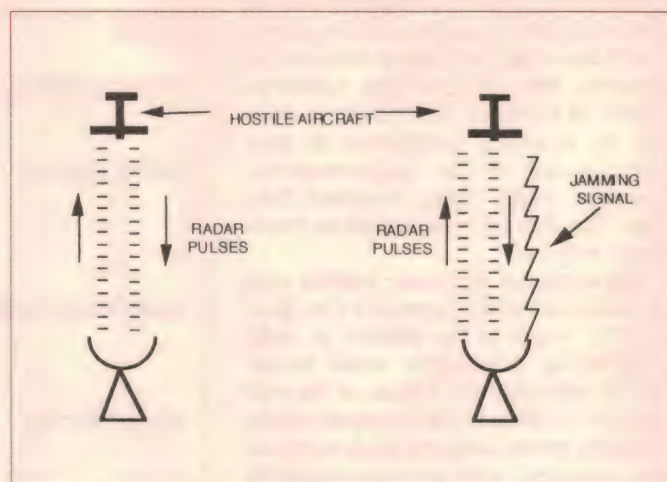
The three main disciplines covered may conveniently be grouped as Communications, Non-Communications and Information Warfares.

Communications Warfare is, as its name implies, directed towards disrupting the enemy's communication systems whilst protecting one's own. Non-Communications Warfare normally concentrates upon radar, guided missile and similar applications,





**Fig.1:** How 'chaff' can be deployed to screen an incoming bomber stream and confuse the defences by laying a false trail. Single aircraft can also dispense chaff to protect themselves.



**Fig.2:** Use of an on-board jammer by a single hostile aircraft approaching a defence system radar. Without the jamming, the aircraft is readily seen on the PPI display.

whilst Information Warfare may simply be regarded as the use of Information Technology for military purposes. Naturally, aspects of these technologies will inevitably overlap. Other, more specialised, applications of the use of the electromagnetic system in electronic combat are not discussed here.

Let us now look at some of the ways a radar or similar system could be rendered inoperative or deceived in some way. Table 1 introduces some general

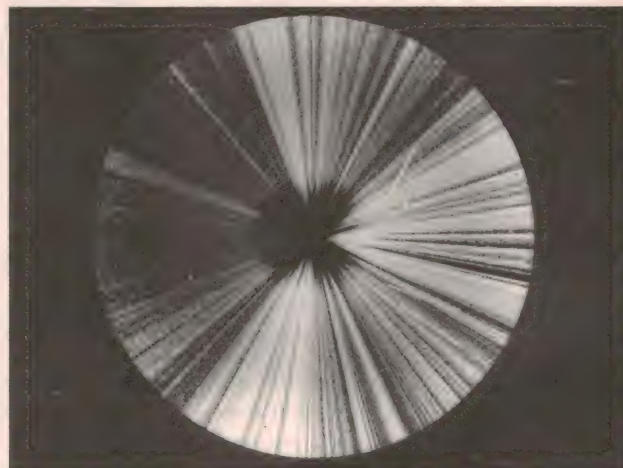
principles. As the systems described are not in themselves destructive of equipment or personnel, they are collectively known as 'soft-kill' systems.

We will now take a brief look at how passive and active jamming could be used to protect aircraft from ground-based radar systems or guided missiles with on-board radar. Only simple examples are given, all relating to aircraft.

Passive jamming using clouds of metallic 'chaff' to conceal potential targets from the enemy's radar system was

introduced during the Second World War. Over 50 years later it is still a cheap and effective method to protect aircraft and other targets.

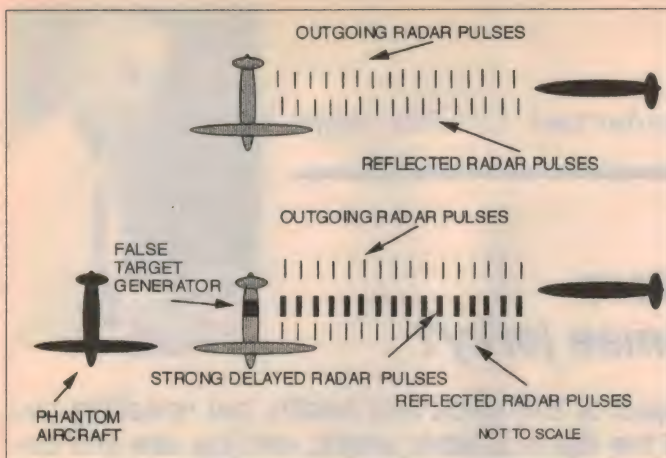
Chaff clouds consist of the large numbers of air-dispersed metallic dipoles which act as reflective antennas — say short strips of metallic foil, cut to the half-wavelength of the enemy's radar, which then produce a huge echo area obscuring the target. Chaff is a favourite anti-radar device, typically dropped from aircraft or



**Fig.4 (above):** The effects of jamming on a PPI radar display — all information has been obliterated in the presence of an effective airborne jammer, without protective counter-measures. (Courtesy GEC-Marconi)

**Fig.3 (left):** A typical modern PPI radar display, in this case showing aircraft over Scotland. Such displays are fed from equipment whose function is to suppress unwanted returns, ground clutter and other noise. (Courtesy GEC-Marconi)





**Fig.5: Use of a false target generator to generate false 'reflected' pulses, to confuse a radar-guided missile into 'believing' the aircraft is further away than its real position.**

deployed by rockets fired from ships. It can cause confusion and delays in defences if properly used, whilst being relatively efficient in protecting individual targets.

Fig.1 illustrates, in symbolic form, how chaff could be used to hide a bomber stream. The left-hand diagram illustrates that, without chaff, the incoming bomber force has been detected and its numbers and positions displayed on the radar's plan-position-indicator (PPI). The right-hand side indicates what would happen if chaff (or 'window' as it may be called) is deployed.

Not only does the chaff in front of the bomber stream hide them from view, but the chaff distributed to the west also returns radar echoes — leaving the defence forces to guess where the correct target is. Some radar systems have the ability to see through chaff, which is slowly moving compared with the aircraft.

Active jamming may also be accomplished, by using a high powered radio frequency noise source. This acts in a fashion similar to an unthinking neighbour creating electrical interference, which blots out your favourite TV or radio program. In the military combat situation the source will normally be tuned to the radar frequency and directed at it, in order to increase its effectiveness. Fig.2 shows the principles involved. Figs.3 and 4 show how a radar system display map could look before and during jamming. A normal tactic in an airborne attack is to have specific aircraft designated as 'stand-off jammers', well out of harm's way, whilst other aircraft attack the target. This is further explained later.

## Deception

Probably the single best way to defeat radar-guided and heat-seeking missiles is by *deception*. This may be done by generating false targets.

In a simple case an aircraft, being targeted by an incoming radar-guided missile using pulses, can use on-board equipment to generate false radar returns. As radar waves travel at the speed of light ( $300 \times 10^6$  metres/second), if the electronic system can generate additional return pulses delayed by only one microsecond, it is easy to show that the missile will 'think' that the aircraft is 300 metres further away — a very comfortable miss! The general, but much simplified, concept is illustrated in Fig.5.

In the second of these articles, we'll look at some further basic techniques of electronic warfare, and also at some of the ways in which it was applied in the Gulf War.

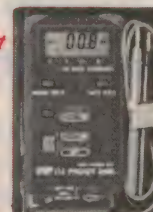
(To be continued.) ♦

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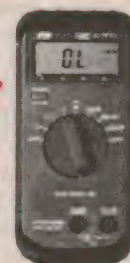


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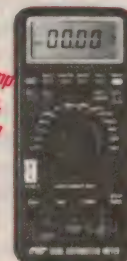


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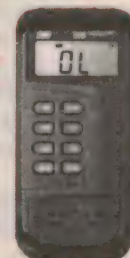


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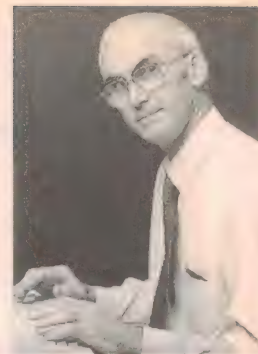
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## Double adaptors, smoke detectors and why are some TV programmes jerky?

This month we're still taking a break from the subject of EM fields and health, but revisiting two other safety-related subjects: double adaptors and the risk of electric shock, and the use and disposal of smoke detectors. A reader also draws our attention to the fact that some TV programmes seem to have become 'jerky' — could it be due to digital compression artefacts, he asks?

Judging from the amount of material turning up on the subject of EM fields and health, we'll probably have to return to it next month. As I predicted a month or two ago, it's such an important and relevant topic that we'd be very foolish to avoid it. In the meantime, though, I thought we'd look quickly at some follow-up material that has arrived regarding topics we've discussed previously — either in Forum itself, or elsewhere.

To start the ball rolling, you may recall that in last December's issue our Vintage Radio columnist Roger Johnson tackled the subject of workshop and equipment safety, and included a warning regarding the old (and now banned) type of 'double adaptor' which reversed the active and neutral connections on one of its outlets. Roger concluded with a cautionary tale of a shock he'd received in the past, involving such an adaptor.

No doubt Roger included the latter tale to drive home his overall message of the need to be 'safety conscious', and also his warning about those old adaptors. Which is all well and good — but there was actually a flaw in his logic, in claiming that the old type of adaptor had been directly responsible for his shock.

I confess I didn't spot this gaff at the time I edited Roger's column, but it was soon brought to my attention in no uncertain terms by a letter from our old friend and hawk-eyed critic in Muswellbrook, Jim McCloy. Mr McCloy is never one to let us get away with anything, and he wasn't about to do so on this occasion either! Despite the implied rap over the knuckles for both Roger and myself, though, Jim's letter is so interesting that I thought you'd like to read it for yourselves:

*The article by Roger Johnson in EA December, regarding old style double adaptors, is not helped by the supposed*

*connection with an electrical shock to a person holding a chassis and touching a soldering iron.*

*Whilst the effects described are quite authentic and tally with a major electrical shock that I survived some 50 odd years ago when I handled a faulty power cable connector with exposed connections (taking the full 240 volts through my arms, down my body to wet feet on a concrete floor), the statement "don't know how it happened" leaves a lot to be desired.*

*If the description is correct, then the reasons for the shock are not directly attributable to the transposed active and neutral, unless there were other factors such as working on a live chassis or using a faulty soldering iron.*

*Transposition of active and neutral normally gives rise to unsafe conditions, particularly on equipment fitted with some form of single pole switching, where the presumption that the equipment is switched off, leads the unsuspecting person to touch wiring and components which may still be 'live'. If the person is also touching an effective earth, then a bite or a shock is the end result.*

*If the soldering iron insulation was poor and its earth connection was not faulty, then the soldering iron should have caused the power fuse to fail.*

*If the chassis was in any way live, then holding it and then touching a potential earth was not at all a wise procedure.*

*The belief that correct polarity of active and neutral automatically gives the user of any equipment a guarantee of safety is an unwise belief, and is one of the proven methods of losing one's life.*

*To have received a shock, the person had to have touched simultaneously both active and neutral or earth. Transposition is secondary, and so there has to be further to the story.*

*One is left presuming that the radio or whatever unit's chassis was still connected to the power supply, giving either an earth path or a live chassis or that the soldering iron had no earth and had an internal fault allowing the iron to become live.*

*The adaptor described is definitely at odds with Australian manufacturing practice, as the writer has an assortment of similar HPM units, many 25 years and older, which in no way have reversed active and neutral connections. Discussions with suppliers of electrical components suggest that Australian double adaptors have never been anything but safe in the past.*

*I certainly believe that all old adaptors, plugs, whatever should be disposed of by physical destruction before disposal. But please don't confuse safety with a supposed story that doesn't appear to be able to hold water.*

*My experience comes from association with a father who had such a high skin resistance that his usual way for checking whether anything was 'live' was to stroke the wiring, fuse, whatever with the tip of a finger. I should also mention that he habitually wore rubber-soled sandshoes.*

*To the uninformed this appears to be very dangerous, but with one's other hand in one's pocket, it is very hard to receive a lethal belt. It is also hard to then continue on in a live situation and later possibly say "I don't know what happened"!*

*Also by not grasping or holding to any connections, the contractions caused by the electrical current flow do not occur, and only leave one with a slightly tingly finger.*

*My greatest problem when I held the broken connector was that the current tried to take charge and contract the*





muscles in my hands and arms. I can still see the muscles corded in my arms as I fought to let go—which I eventually forced myself to do. I presume that like my father, my fairly high skin resistance plus the knowledge that I had to beat it helped me.

The story also has another conflict in it, in that the resulting muscular activity appears to show the opposite of the muscle contractions that usually occur. The further description describes a person reacting violently to the stimulus, which can easily occur from induced electrical voltages which may be higher than mains voltages but not having sufficient energy to cause fatal results unless one is caught off-balance on top of a ladder or staging.

I once worked with an electrician in a margarine factory who would not agree that a large heavy electric workshop drill that we used was prone to this type of fault. When tested in his nice dry workshop he could find no problem, but the day came when he himself used it in the works whilst up on a stage. He was particularly lucky that his inadvertent dance some 12 feet above ground didn't bring him crashing down, when the beast of a drill gave him a taste of induced voltage. Suffice

to say that the drill received suitable treatment, but from then on was always treated with suspicion.

This same electrician commissioned a brand new industrial charger for the works electric fork lift—unpacked it from its crate, put it on his workshop bench and switched it on. He inadvertently then put a hand on its case and was thrown across the shop—a case of the then-new continental wiring colours, with it being wired up by the New Zealand agents with the active connected to earth and the earth connected to active.

The important message out of this is that one should never presume that any electrical equipment or tool is safe until proven, and that a quick touch is better than a quick death.

Whilst I use a test lamp, neon or voltmeter when working on 240 volt equipment, I still touch my drills, grinders, routers, saws, welder and other electrical equipment to feel whether that creepy sticky alternating current feel is present, especially in wet or damp conditions. I also switch equipment on momentarily without holding in a strong grip. I wear synthetic soled shoes and definitely put my idle hand in my pocket in those circumstances where an invol-

untary grab, especially to a nearby earth, could mean a hot handful.

Another thing about mains voltage soldering irons is that in over 50 years of using them, I've struck quite a few leaky ones. Where for use on metal roofs or similar situations, I would only use them where an isolating transformer was available.

No doubt with earth leakage detection in use, any old equipment with these problems would not be able to be used and so would have to be repaired or thrown out.

Well, there you are. My thanks to Jim McCloy for spotting the *non-sequitur*, and for chastising us in a way which is both interested and basically reinforces Roger's aim of raising safety awareness.

In passing, the descriptions by both Roger and Jim of their electric shocks reminded me of the worst one I've ever received myself. It was back in the late 1950s, before I even joined EA, when I had built my first TV receiver. The 2000V EHT supply for the 5" CRT used a voltage multiplier from the 385-0-385V transformer secondary, using some old 6H6 rectifier valves and a bunch of high-voltage 10nF capacitors. Somehow I accidentally touched one of the capacitor leads with one hand while



holding the earthed chassis with the other — and promptly ended up in a heap on the other side of the room, dazed and with heart racing from a huge surge of adrenaline. I've been a little more cautious ever since!

## Smoke detectors

Moving on, though, you may recall that we've discussed the safety aspects of smoke detectors a couple of times recently — in the March issue last year, and again in the September issue. In both cases the discussion centred around the fact that the sensor element in these detectors generally contains a small quantity of Americium 241, which is both radioactive and highly toxic.

Soon after the September issue was published, I received the following letter from Mr Felix Scerri, of Ingham in Queensland:

*I share the concerns of those worried about the various safety aspects of the ionisation (radioactive) type of smoke detector. I can regrettably recount at least 10 and possibly more true stories of detectors just 'thrown away' in the bin. Most of them, I believe, were disposed of in this way out of ignorance.*

*It is true that detectors and their associated paper instructions give advice on disposal, but I've come to believe the average buying consumer doesn't take much notice — and even worse, doesn't really care.*

*Most counter and sales staff I have questioned are also seemingly blissfully unaware of possible radiation hazards and/or proper disposal. Yet we are told these alarms are vital in homes.*

*Incidentally is there a danger if these devices are destroyed in a fire and the radioisotope released? I've asked many people, including 'experts', and haven't really had a concrete answer. The level is supposed to be 'safe', but I wonder.*

*Back in the 1960s and 70s detectors in use employed Radium 226 as the ionising source, in much greater amounts than the Americium 241 used today. By the then standards, the amount used was considered 'harmless', but not by the standards that exist today.*

*It seems odd to me that in a world where the word 'nuclear' invokes such unpopular notions generally, here is one curious exception — or IS ignorance bliss?*

*I wonder if the ignorance is also evident amongst government officials, who have now apparently decided to make*

*these detectors mandatory in new dwellings and even talk of 'retro fitting' into existing residences.*

*It is nice to see alternative types of detectors (optical types) on the market, but guess what? Yes, they are considerably more expensive, and as we all know economics often wins the day.*

*I suspect we are all going to have a big problem in a very short time if we don't sort things out very quickly. I wonder how long it will be before some enterprising lawyer finds a link between these detectors and cancer and/or other radiation induced illness. Although I've come to associate some lawyers with opportunistic money making, I'm almost hoping that this will happen, because I think they could well be right.*

Thanks for those comments, Mr Scerri. Like you, I'm a bit skeptical that many customers will pay due attention to disposing of these detectors properly. It seems a bit naive to assume that they'll do so, simply because they're asked to in the instructions...

Your question about what happens to the Americium when the detector is destroyed in a fire also seems a very pertinent one. Perhaps someone from the suppliers or their testing labs may be able to explain this — but until then, I'd make sure you wash your hands after touching anything in burned-out buildings, just to make sure.

By the way, readers may recall that in his original 'letter to the Editor' in March 1996, Alan Elliott VK3AL asked how these ionisation-type smoke detectors actually worked. We couldn't find any information on this at the time, but ever since then I've been keeping an eye out for an explanation. I finally found it in a recent issue of *New Scientist*, that excellent magazine for anyone interested in science and technology.

It was actually in the magazine's 'The Last Word' section, where readers ask interesting questions and then other readers send in explanations. *New Scientist's* editor presumably selects the most interesting and informative replies. Anyway, someone had asked a very similar question to that posed by Alan Elliott:

*Q: I recently bought an ionisation smoke alarm and was surprised to discover a small canister containing americium 241. There are no clues in the instructions as to how the isotope detects smoke, apart from noting that steam or condensation can also trigger the alarm. How does it work?*

The magazine then quoted the following explanations, firstly from Robert King of West Lothian in the UK:

*In a smoke alarm two small and parallel plates are separated by a distance of about one centimetre. A tiny amount of radioactive material (usually americium 241) at the centre of one of the plates emits alpha particles ( $^4_2\text{He}$ , a Helium nucleus) which collide with air molecules. During the collisions, the air molecules are ionised to form positive and negative ions.*

*The voltage from the battery makes one plate positive and the other negative, so each plate attracts ions of opposite charges. This creates a current in the circuit attached to the plates. The presence of smoke particles (or steam or condensation) between the plates reduces the current, because the ions that collide with a smoke particle are usually neutralised. This drop in current triggers the alarm.*

This basic explanation was augmented by reader Alan Calverd of Bishops Stortford, who added:

*Apart from its simplicity the ionisation smoke detector has a degree of fail-safety. If the battery voltage falls, so does the ion current, and the alarm sounds.*

Stuart Robbins of Calne in Wiltshire then added a further reminder about correct disposal:

*Smoke alarms should not be disposed of in the normal rubbish bin as the isotope can contaminate water courses.*

And finally David Abbott of Millom in Cumbria added a small note about correct testing:

*Pressing the 'test' button only tests the sounder on most smoke alarms. The proper way to test the alarm is to direct steam or smoke into the detector.*

So there you are. It's a bit belated, but thanks to *New Scientist* and its helpful readers, we now know how the detectors work — at least in basic terms.

## Why so jerky?

Moving on again, Melbourne reader and one of our frequent contributors to these columns Mark van der Eynden has sent me a fax on a very interesting and topical subject. In the light of recent developments in the DVD and digital TV broadcasting area, I thought you'd like to see what he has to say:

*Please allow me to toss a new subject into the Forum fires, that of Television Satellite Link Picture Quality.*

*I have noticed over the last couple of years that the picture quality of television transmitted via satellite is not what it used to be. I originally thought that the networks were just cutting corners*



by only sending every second, or third frame over the link, so as to save valuable \$\$\$, but now I'm not so sure.

For example, notice what happens during a Grand Prix race when the cars come to a corner. They seem to jerk around the corner in about three or four jumps. A similar thing happens in tennis broadcasts: when the ball is served, the player seems to serve in a two or three jerk movement. Sometimes the ball even appears to stop part way across the court.

Now we all know there is a limitation with the 25 frames per second rate, but it never used to be that bad. I find that these broadcasts lack the 'grace' of the local broadcasts, and that I find them less entertaining.

Now I come to the opening of the Atlanta Olympics. Viewing the ceremony I wanted to have a look at everything, not just at the central focal point of the camera. Now I have a large 72cm TV with a good antenna, so I was expecting a good picture. However, when I looked closely at the audience, all I saw was a series of coloured boxes, which from a distance looked like rows of seats with people in them.

The ceremony was quite spectacular when you only tried to take in the whole picture at once, when you tried to focus on detail, there was none. The golden masks looked good close up, but if you tried to look at one when the screen was filled with the 'Drum Machine' the mask itself became a rather haunting sight.

Having read 'Moving targets: Pay TV in Australia' in your August EA, and Scientific-Atlanta MD Steve Dean's comment about MPEG "with its own type of artefacts, actually looks much better", I was beginning to get suspicious about what was going on here.

Later I looked very closely at a studio shot, looking at the presenter's eyes I saw two dark brown rectangles opening and closing — no whites, no pupils and definitely not round. One would think that the 'artefacts' should be minimal here. I doubt that anyone could describe the removal of a presenter's eyes as acceptable 'lossy compression'...

I suspect that MPEG allows you to compress to a target data rate, say 128kb/s, 256kb/s, etc., and so it appears the networks are trying to achieve a data rate that is too small to contain all the information that can be displayed on a target television set. Presumably purely to lower the costs of the satellite link. One wonders how anything can be compressed out without affecting the target picture, but that may be another question.

How the networks expect to attract people to TV by sending out an inferior quality signal is beyond me. They may get huge ratings, but I expect client satisfaction is suffering.

If this kind of 'lossy' transmission is to become standard, one wonders how HDTV will ever sell, when it appears. Surely the whole idea should be to increase resolution, not decrease it.

I wonder what the networks really are doing to our satellite relayed broadcasts, and if they are using MPEG to compress them, what standard they are using to measure 'acceptable losses'.

Well, as you can see Mark has certainly raised some very interesting points — thanks, Mark. Perhaps one of the engineers from a TV network might like to clarify the situation, or at least either confirm or deny that MPEG is being used for the satellite links. If so, it would be very interesting to learn what the average data rate is. My understanding is that using an MPEG-2 data rate of 1.5Mb/s or less for anything other than a 'talking head' image causes picture degradation which is quite noticeable to many viewers, so if the networks are trying to use lower data rates again, this might easily explain 'jerky motion'.

Actually some similar comments were heard recently at a press function when the ABA (Australian Broadcasting Authority) released the final report by its Digital Terrestrial Television Specialist Group, with recommendations for the way Australian 'free-to-air' TV broadcasting should change over to digital technology. A number of people — including a well known and very experienced TV engineer — expressed concern that broadcasters would have to be very careful with low bit rate/narrow band MPEG broadcasting, lest they 'put viewers off' digital television by delivering end-user images that are clearly inferior to existing analog programme material as received.

As Mark van der Eynden points out, most people are going to expect digital transmission to deliver pictures (and sound) that are noticeably better than those they currently get with their existing analog receivers. Otherwise, they're going to be either very reluctant to invest in a new digital set, or most unhappy with their purchase if they've already done so.

Ironically, I get the impression that as far as some of the broadcasters are concerned, the main appeal of digital technology is that it'll allow them to squeeze more channels into their currently allocated bandwidth — to make more money. Or alternatively, to allow them

to save money by 'renting' a smaller bandwidth to transmit their existing programme. Somehow they seem to be assuming that the viewers either won't notice any degradation in received quality, or won't care. All of which sounds pretty naive, to me.

I don't know about you, but I'm going to take a bit of convincing before I personally lash out and buy a new digital set. They're not likely to be cheap, and at the very least I'll need to be assured that the received picture and sound they provide will justify the expense.

If I were the TV networks, I'd be giving top priority towards using digital technology and MPEG-2 compression to fit single really impressive widescreen HDTV programmes into spare existing 7MHz-wide channels. That's the sort of material likely to entice us all into buying a digital set — not using the technology to grind out additional minimum-bandwidth 'jerky motion' signals.

As Mark van der Eynden's letter suggests, viewers are not fools; they're surely going to notice any attempt by our media moguls to short-change them. Don't you agree? ♦

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# NEW BOOKS



## RF design

**SECRETS OF RF CIRCUIT DESIGN**, by Joseph J. Carr. Second edition, published by McGraw-Hill 1997. Hard covers, 243 x 193mm, 568 pages. ISBN 0-07-011672-5. RRP \$64.95.

The first edition of this book was so popular among technicians, radio amateurs and enthusiasts that the author and his publisher were encouraged to produce this updated and enlarged second edition. Mr Carr is of course a very prolific and well-known author in the USA on electronics and amateur radio topics, and writes a regular column in that country's *Popular Electronics*.

In this new edition he has added chapters on VLF receivers, designing and building LC filters, and using double-balanced mixers. He has also expanded the section on direct-conversion receivers. All of these additions were in response to 'positive feedback' from the first edition, as he explains in the introduction.

Like the first edition, it's still a very good introductory book on the practicalities of RF circuitry. There's a satisfying amount of basic theory and maths, plenty of circuit examples, and a lot of solid down-to-earth information on practical design and servicing techniques.

I did notice a few frustrating publishing errors, like a circuit diagram that is clearly wrong (Fig.5-27, page 141) and a graph with a wrongly marked axis (Fig.9-17, page 240). Some of the chapters are a bit sketchy and unsatisfying, too — like chapter 17 ('Building and Using the RF Noise Bridge')

But on the whole, the book has been well produced and is both readable and informative. I'd recommend it to anyone

just starting in RF design, or wanting to go 'a bit deeper' into amateur radio.

The review copy came from McGraw-Hill Australia, of 4 Barcoo Street, Roseville NSW 2069. (J.R.)

## Battery technology

**BATTERY REFERENCE BOOK**, by T.R. Crompton. Published by Butterworth-Heinemann, 1995. Soft cover, 185 x 270mm, 650 pages. ISBN 0-7506-2567-8. RRP \$125.

This is a large and comprehensive book about most kinds of battery in current use — although it does omit anything about nickel metal-hydride and lithium-ion batteries, which are now being increasingly used.

Notwithstanding these omissions, there are literally hundreds of battery types that are presented in great detail, including lead-acid, nickel (and the many derivatives), silver, alkaline-manganese, carbon-zinc, mercury, lithium (but not lithium ion), manganese-dioxide, metal-air, zinc-halogen, sodium-sulphide and water activated types.

The book is broken into six parts, with each part discussing one aspect of each type of battery. It starts with an introduction and guidelines about battery selection. This is followed by Part 1 which is about battery characteristics, and Part 2 describing battery theory and design. Part 3 is about battery performance evaluation, and Part 4 discusses applications. Battery charging is described in Part 5.

Part 6 is titled Battery Suppliers, and gives extensive manufacturers' data about batteries. Each battery type number is presented, with details on its capacity, size, voltage and so on.

The book uses a lot of tables as a way

of presenting information in a concise and accessible way. There are plenty of graphs, but very few illustrations of battery construction. A lot of mathematics and chemical equations are used, and the writing style is relatively formal; but it's a valuable reference on batteries.

The review copy came from Butterworth Heinemann, of PO Box 146, Port Melbourne 3207. (P.P.)

## Satellite TV

**THE PRACTICAL GUIDE TO SATELLITE TV**, by Garry Cratt. Published by the author, 1997. Soft covers, 298 x 210mm, 114 pages. ISBN 0-646-30682-0. RRP \$39 + \$5 P&P.

This latest book on satellite TV comes from my former colleague Garry Cratt, nowadays the Technical Director and owner of local satellite TV firm AV-COMM. Garry did his training in the R&D department of AWA, and after that spent some 11 years at Dick Smith Electronics — many of them as Manager of that company's service department. That's where I met him, actually.

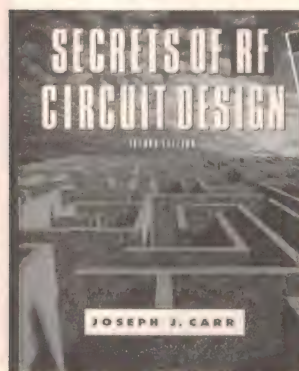
As you'd expect from Garry, he's produced a very businesslike and practical book, written especially for the Australian reader and leaving out anything that's not relevant here. There are no reams of footprint maps for satellites that cover only the northern hemisphere, for example, and just about all of the pictures are of gear available here.

It's also written with a clear emphasis on telling you 'what it's all about, and how to do it', in understandable language.

The chapter headings give a good idea of its coverage: Brief History of Satellite Communications; Principles of Operation; Earth Station Components; Encryption Systems; Video Compression; and Setting Up a Satellite TV Receiving System. There's also a Glossary of Terms and a 46-page Appendix with information and footprints for all satellites 'seen' from Australia.

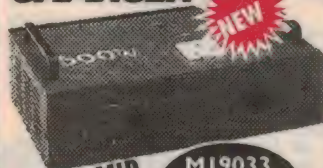
It's all clearly written and well presented, and should be of considerable value to anyone wanting to know more about this very topical subject.

The review copy came from AV-COMM, of PO Box 225 (198 Condamine Street), Balgowlah 2093. It's available from AV-COMM for the price shown. (J.R.) ♦





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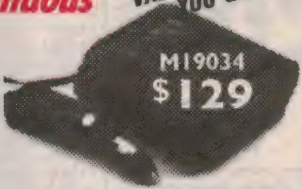
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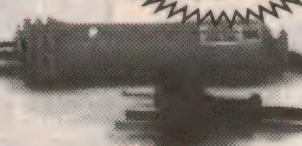
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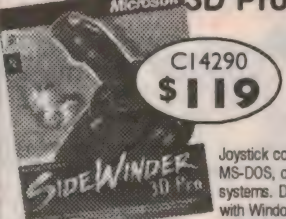
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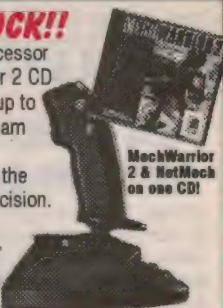


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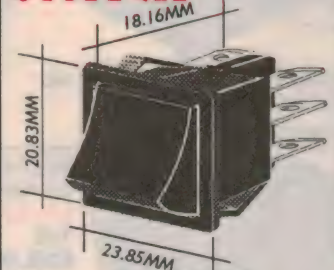
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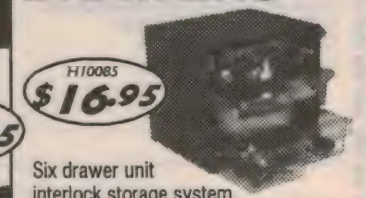
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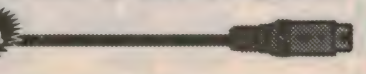
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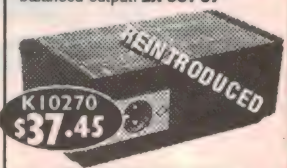
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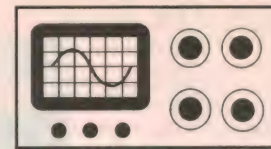
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# THE SERVICEMAN



## *Even when it was repaired, the pinball machine still wouldn't play fair!*

This month I have a story about how small things can be more important than they seem, when you're trying to fix an elderly Sony CTV. There's also a tale about a confusing videotape mixup, and finally an interesting servicing job dealing with a piece of equipment we've never covered here before: a microprocessor-controlled pinball machine. The causes of most of its problems turned out to be remarkably familiar, though...

Our contributors have had pride of place at the head of each column for all of the recent issues. This month I'm giving myself top billing, so see what you think of these two items...

Isn't it odd how you can sometimes miss the point, even when the correct answer is served up to you? An example turned up in my workshop just the other day.

A friend of mine from a country town rang me a week or so back and asked if I had a circuit diagram for a Sony KV1830AS. This is now a very old set, being one of the first colour sets released by Sony in Australia.

I quizzed my friend about the state of the picture tube. I don't know of any examples of this model still working properly, and those that are still going at all do so with badly discoloured pictures. As I recall, it was always the

green gun that had lost its emission, leaving a magenta-coloured image often compounded by low brightness and poor contrast. In simple words, the pictures were a mess.

In this case, it seems, the owner was still happy with the picture and was quite willing to spend any reasonable sum to have the set fixed. So, my friend asked me for a photocopy of the circuit and for any clues I might have as to why the set would not start up.

It so happens that many years ago, I attended a lecture by a specialist in servicing this model and most of the 100-odd service notes that were outlined that evening were pencilled onto the diagram. Since then, I've added one or two of my own findings but for the most part, that lecturer covered nearly all the faults I've ever seen in this model.

So it happened that I was able to give my friend a list of a dozen or so things to look at in the power supply and line output stage, each of which was known to be responsible for the symptoms he was complaining about.

He went off confident that he would be able to solve the problem, but a week or so later was back on the phone. He'd tried everything I had advised, and many other ideas of his own, but still couldn't get the old Sony to fire up. Then he asked would I please have a look at it for him.

Well, what are friends for if not to help each other? And, since I am now more or less retired, I couldn't argue that I was too busy. So this morning the set arrived on my bench.

I took out the service manual, turned to the circuit diagram, and looked at the notes around the margin near the power supply.

One of the notes stood out like the proverbial sore thumb. It said simply 'Replace R628 and R639 — goes high!'

No other comments. No symptoms. Just the bald statement to change the resistors.

Then I remembered back to the early days of this chassis, when changing these resistors was almost routine. Any set that came in with the original non-flammable ceramic coated resistors still in place was an immediate candidate for a 'resistorectomy'.

The resistors are of an unusually low value, 1 ohm in the case of R628 and 1.2 ohms for R639. They are wired in parallel for an effective resistance of 0.6 ohm and are located in the emitter circuit of the chopper transistor. Their purpose is to sense the chopper current and so provide a drive voltage for the ECL (excess current limit) circuit.

As I mentioned above, I have changed hundreds of these resistors, not always in sets that were displaying any sort of symptoms. It's just something one does automatically, and in this case I repeated the exercise without thinking about it. Just as well really, because it saved me hours of time.

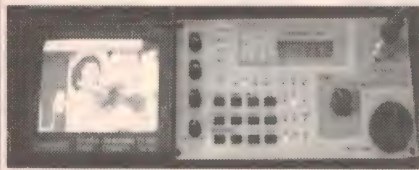
When I first metered the resistors, I got all kinds of ridiculous readings, like 4.8 megohms, and 7.2 kilohms etc. It wasn't until I took my meter probes into the garage and sharpened the points on the grinding wheel that I was able to penetrate the layers of oxide on the surface of the resistor leads and get a reasonable reading.

(This was a reminder to me and a lesson to young servicemen that when measuring low value resistors, it is not sufficient just to hold the probes on the resistor leads. The contact resistance can be several ohms in a good circumstance, and hundreds or thousands of ohms if there is ANY trace of corrosion on the leads.)

The reading that I eventually achieved was 0.8 ohms, which suggested to me that one or other of the two

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Anyway, I changed them, switched on and away it went — just like a bought one. The picture lacked a bit of green to my way of thinking, but the owner had been happy with it; so I should worry! Just the same, I checked to see if there was any adjustment left on the green drive and there was plenty. So it looks as though this old Sony will be able to keep going for a year or two yet.

He had checked the resistors, but imagined that 0.8 ohm was close enough to 0.6 ohm in the circumstances and had gone on to look for the fault

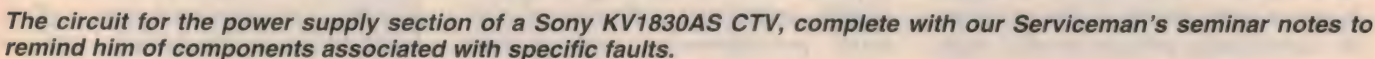
My friend would have queried a reading of two or three ohms, but he felt that 0.2 ohms difference was too little to worry about. Yet when you think about it, 0.8 ohms is a 33% increase over 0.6 ohms, and most critical circuits are designed around a 5% tolerance.

Experience has proved that any increase at all in the resistance in this circuit can cause trouble. Which is why I check these resistors automatically, and replace any that show even the slightest divergence from the specified values. I can only suggest that you do the same.

Now for my second act, I present a story developed from a recent phone call from another friend I'll call 'Arthur'. While not exactly a serviceman tale, it at least carries a lesson for all who service (or would service) video recorders.

It's as well that she did so, because problems showed up an hour after nephew began to play the series...

The third tape in the set was quite normal, just as the first one had been. Tapes one and three played perfectly and elder son/nephew was two-thirds delighted with aunty's thoughtful Christmas present.





Naturally, elder son asked Arthur, who is a qualified electronics technician and fairly knowledgeable on VCRs and TVs, what could be wrong with one of his gift tapes. After a very careful appraisal of the symptoms, Arthur proclaimed that the second tape must be an NTSC version. There was nothing on the packaging to suggest that this was so, but it was the only explanation that could account for the display on the screen.

That's when all the trouble started....

Soon after Christmas, Arthur took the tapes into the local branch of the national chain and headed for the 'Entertainment' department on the third floor. We won't talk about his problems with trying to operate a modern microprocessor controlled elevator, but it's sufficient to say that he eventually arrived at the video-tape counter.

The lass that he spoke to at first couldn't understand what he was talking about so he asked if he could demonstrate, on one of the several VCR/TV setups around the showroom.

He loaded tape one and, as expected, it played perfectly. Then he loaded tape two, expecting it to display the fault symptoms. But it didn't. The tape played perfectly and spot checks at various places throughout its length confirmed that there was indeed nothing wrong with it.

Arthur couldn't understand why the tape showed this contrary behaviour, so he asked if it could be played on another machine, just to be sure. The second VCR/TV combination was of a similar vintage (i.e., brand new) to the first one and as might be expected, the tape played perfectly.

By this time the young sales assistant was beginning to think that Arthur had one or more screws loose.

Just then, the Department Manager came along and asked "...is there a problem?" Fortunately, the manager was a little more clued-up than the young sales assistant and he asked Arthur to bring the questionable tape over to another VCR/TV combination, this time a cheaper and less elaborate assembly than the ones that had been used earlier.

This machine produced the result that Arthur had been expecting, garbled sound, vertical and horizontal rolling and all.

The Manager agreed that the tape had to be faulty and apologised to Arthur for the trouble that he had been given. He immediately selected another copy

of the tape set and checked each one by testing it on the simple machine. This time the tapes were all perfect, so Arthur went away happy.

But the question remains:

The three-tape sets all came from a local source and were intended for the PAL market. Yet in Arthur's case, one copy of an NTSC version had become mixed up with the local copies. And what is worse, there was no indication on the packaging as to which standard the tape had been made for.

How could this happen? And how many VCR repairs have been initiated because of a wrongly packaged tape?

The showroom confusion came about because so many up-market VCRs and TVs nowadays have automatic PAL/NTSC switches. The lass in the showroom was unaware of the significance of this modern development and was quite prepared to tell Arthur to take his problem elsewhere. Only the fortuitous appearance of the Department Manager saved what could have become a nasty situation.

So therein lies a story. The vast majority of tapes sold in Australia will be of the PAL persuasion, whether or not the original versions were PAL or NTSC. Nevertheless, occasional imports or packaging errors might put the wrong variety on the local market and it's as well to be alert to this possibility.

If I might make a suggestion, you should try to get an NTSC tape and play it on a variety of locally common machines and television sets. Get to know the symptoms so that you won't be tricked into looking for faults that are not really there.

## Fixing a 'pinny'

Our contributor's story this month comes from Raffaele (Raff) Lerro, from Southport in Queensland. Raff offers a tale about reconditioning something we haven't seen in these pages before — pinball machines.

At one time these machines were entirely electro-mechanical and therefore would not have rated a comment in these pages. However, from the early 1970's onward, electronics took over more and more of the logic functions, until, as you will see from Raff's story, they became almost completely electronic.

Here's what our contributor has to say...

*My very high interest in all things with a power cord attached promotes a healthy underhouse collection of electronic paraphernalia, ranging from*

*ancient bakelite radio receivers to a Honeywell minicomputer, a total of six pinball machines and a locally designed and built video jukebox, using a multi standard VHS VCR as a playback device controlled by (of all things) a humble Commodore VIC20.*

*The story that follows relates to one of the pinball machines, a 1979 model called 'Howzat!' built by an Australian company named Hankin.*

*It all started early one Saturday morning with a telephone call from a neighbour from years past. It seemed he had a mate who had been given an old pinball machine, and as it seemed 'brain dead' he wanted to see if I could fix it for him so that he could sell it. This particular neighbour knew all too well my strange love affair with those marvellous machines, and knew I couldn't knock back the opportunity to play with yet another one.*

*So it duly arrived in the back of an old van, and after much grunting and sweating the beastie was in my shed. Later that afternoon, I decided to have a look at this new device and plugged it in for a smoke test. So far so good, with no smoke leaking out — but not much action either. A few lights on the playing field lit up, but nothing else happened.*

*As this machine was of an early microprocessor controlled variety, it has a self test button located within the front door, so I pressed it to see what would happen. Some different lights came on, but that was it. I opened the front door and removed the playing field glass so that I could prop up the playing field for a look around.*

*Here I found a most pleasant surprise — a manual! This is a somewhat rare thing to find in a machine as old as this one, and with circuit diagrams too! This was beginning to look decidedly hopeful. Firstly I had a flip through the manual to familiarise myself with the workings. This manual was one of the best I have seen, with block diagrams of all of the circuitry and detailed schematics.*

*After studying the block diagrams and looking over the circuit boards in the machine's head, I saw a couple of legs poking out of one of the boards but with no component attached. I figured that this was as good a place to start as any, so I looked in the manual to see what should be there.*

*It turned out to be a hefty six-amp diode, that must have got so hot in the past that it simply melted its way off the board leaving its legs behind. I replaced*



it with a couple of paralleled diodes from the junk box and switched on.

I now had several game solenoids buzzing uncontrollably on the playing field. It seemed that there were at least two shorted SCRs on the lamp and solenoid driver board, and so these were also replaced with bits from the junk box.

I then had all of the bumpers going and the flippers worked too, but still no score displays or sounds. I needed the displays to work next, as the machine's diagnostics use these to communicate the results of tests etc.

Firstly, as I was taught so many years ago, I checked all of the power supply rails for correct voltage — and found no problems there. Next, I studied the circuit to see how the displays are driven. It seems that all five displays (one for the number of credits and ball in play, plus one each for four players) are the same and wired in parallel, except for a latch enable line to select which display the UPC is addressing.

So I figured that as all of the displays were dead, there must be a common problem and that there was probably nothing wrong with the individual display units. It was time for the heavy duty fault-finding equipment, so out came the CRO. I went looking for data going to the display units from the UPC.

This looked fine, just nice square-edged data on all of the segment data lines. I replaced a 4502 IC that is in the display latch enable lines, but this produced no joy. It was about this time that I noticed a line from the MPU board marked 'display blanking', so I checked it with the scope and found just low level hash.

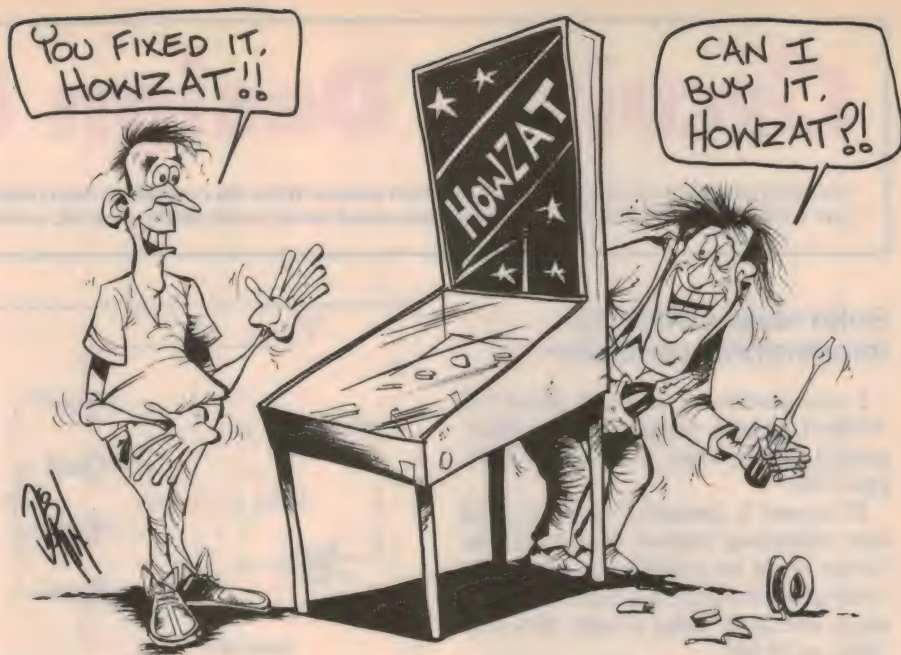
I back tracked past a couple of gates looking for good data. There is a 47nF ceramic capacitor in part of this circuit that proved to be acting more like a resistor than a capacitor, so I replaced it with a green cap from the junk box.

I then had the displays operating, so things were looking up! But I wanted sound too, so it was on into sound board territory to investigate...

I noticed that this machine had two 6802 UPCs, one for the game proper and one for the sound. So after consulting a data book to see just what a 6802 was (and did), I swapped the two and fired up.

But now I had no action at all and wondered could the sound board's UPC be faulty? There was only one way to be sure. So I was off to the local electronics shop for a 6802 — where my friend behind the counter thought it was very amusing that I would want such a 'useless' part as this old 8-bit UPC.

When I told him what it was for, he



became quite excited about the whole idea and wished me luck with the machine's restoration. I rushed home and plugged the new UPC into its socket, switched on, and no sound!

Firstly, I swapped the new UPC into the MPU board to check its operation. My friend at the electronics shop thought that the 6802 was a masked-ROM type or one that needed programming in order to function correctly, like a micro-controller, but all was well here as the new UPC performed exactly as the old one in the MPU board.

Being suspicious of the ceramic capacitors used in this part of the circuit, I probed about with my multimeter and found several more which had an identity crisis and thought that they were resistors. So after replacing them all, I now had glorious sound.

Driven by my success so far, I set about replacing all of the globes that needed attention and spraying a shot of CRC 2-26 on all of the contacts that I could find. CRC seems to agree with these old pinballs and helps the old electro-mechanical ones no end.

I also found several contacts on the power supply board were very badly corroded due to long term overheating, and corrected this by soldering the wires from the wiring loom straight to the board.

After polishing the play area with non abrasive car polish, and cleaning the machine generally, it looked fantastic. I played this thing day and night — I just couldn't help myself. It is a good game to play and very fast, but it still had one very annoying habit of calling 'TILT' randomly and ending the ball in play.

It seems that this fault had been the cause of someone else's frustration in

the past, as the entire tilt mechanism, (which is a plumb bob type of pendulum suspended in a ring which forms the second contact) had been removed and left lying on the inside of the machine.

I looked at the tilt mechanism left bolted to the inside of the case for clues, and there noticed another one of those wretched ceramic caps across the contacts. So after removing it, the machine now plays fair...

As an ending to this story, it might come as no surprise to some that I have fallen in love with this machine and don't really want to part with it. And as the owner only wanted it repaired for sale and has no other interest in pinball machines, I think that I may just have to be the buyer!

So how about that? Or should I say 'HOWZAT'?

Thanks for that story, Raff. As I said earlier, we haven't had any mention of these machines in the past, and yet they are just as electronic as any other appliance.

I appreciate your comments about ceramic capacitors, too. During the 1970s a lot of new component types were put on the market, yet so many of them turned out to be unreliable in the long run. I can think of tantalum capacitors and ceramic coated, flame proof resistors as just two of these products that began with great promise, but eventually became so unreliable as to bring general condemnation on the entire range of products.

Thanks for your story Raff, and we'll look forward to more yarns about your fascinating 'underhouse' collection.

And that's all for this month. I'll be back next month with more service stories, if the fates are willing. ♦



# Circuit & Design Ideas

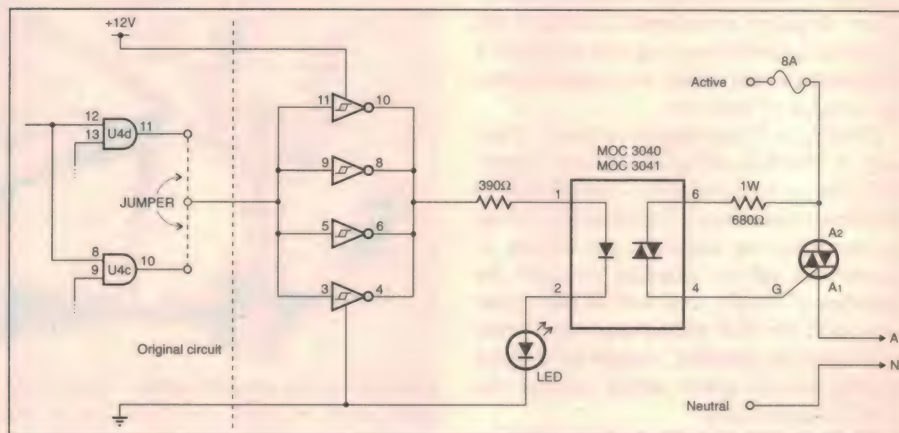
Interesting original circuit ideas and design tips from readers. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide any further information.

## Solid state switch for temperature controller

I was interested to read about the 'Budget priced temperature control' project (Glenn Pure, EA August 1994, pp82-86).

If anyone is interested in using solid state switching instead of a relay, the circuit could be modified by using the solid state switching described in a previous article by John Clarke (EA July 1984, pp76-85).

Fig.1 shows the modification. The circuit is identical to the 1994 circuit up to the 'Jumper' connection. From the jumper, however, instead of going to the transistor switch (as in the original design), the signal goes to the 74C14/40106 hex Schmitt trigger as per the 1984 circuit. In the 1984 circuit, the inverted output from the Schmitt triggers (four in parallel) controls the opto-isolated triac driver



which in turn controls the switching of the triac.

The supply to Schmitt trigger is taken from the 12V rail in the 1994 circuit, rather than 15V in the 1984 circuit. Also, rather than supplying the heater directly from the 240V AC mains, an added measure of safety

could be provided by using an isolating stepdown transformer (of appropriate power capability) to provide 110 VAC.

It is hoped that these suggestions don't conflict too much with the 'budget' aspect of the original project!

L. Toussaint

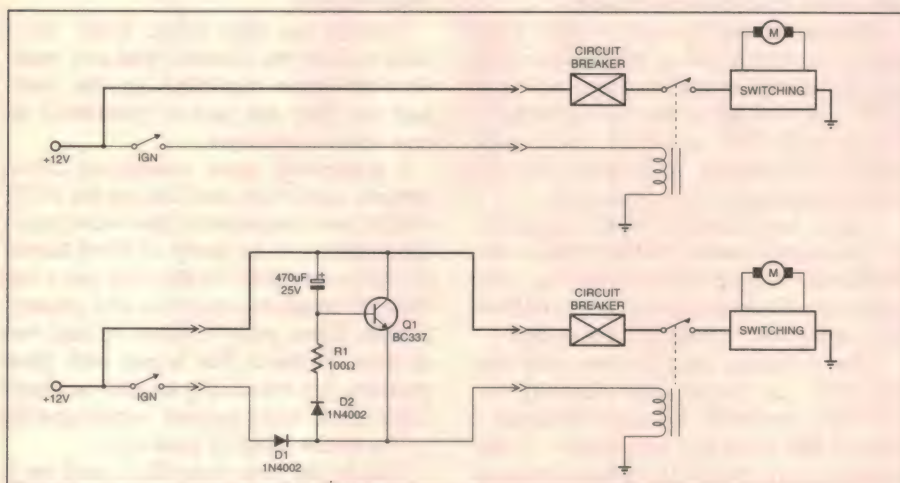
Shelly, WA \$30

## Delayed turn-off for power windows

The power windows in my car only work when the ignition is on. This is often very inconvenient because I often stop the car, switch off the engine, remove

the keys and then notice that the window is open. I then have to find the right key, switch on the ignition again, close the window and switch off the ignition again.

After putting up with this situation for a few years, I decided to do something about it. This involves delaying the



removal of power to the window control circuits until around 30 seconds after the ignition is switched off.

My car is a Subaru 1800 and has a two-pin connector where the optional power windows wiring harness connects to the main wiring loom. This carries a heavy, permanently energised, +12V feed for the motor current and a light, switched +12V to operate the relay as shown in the top circuit diagram.

By buying a matching connector set, I was able to make up a delay circuit which is simply inserted between the existing connectors. Only five components are needed as shown in the bottom circuit.

In the normal state, with the ignition off, C1 will be charged via Q1 and the relay coil. When the ignition is switched on, the relay operates via D1 and C1 discharges via R1 and D2.

Now when the ignition is switched off, the relay remains operated by Q1 whose base current is slowly charging C1 in a bootstrap mode. The relay releases when C1 is full.

D1 is necessary to stop Q1 attempting to supply all of the car's ignition circuits.

Graham Leadbeater

Ringwood, Vic.

\$30

**WIN OUR 'IDEA OF THE MONTH' PRIZE!**

As an added incentive for readers to contribute interesting ideas to this column, the idea we judge most interesting each month now wins its contributor an exciting prize, in addition to the usual fee. The prize is a compact CCD video camera module from sponsor **Allthings Sales & Services**, offering 460 TV lines of horizontal resolution and 0.05 lux sensitivity, and valued at \$199.00!

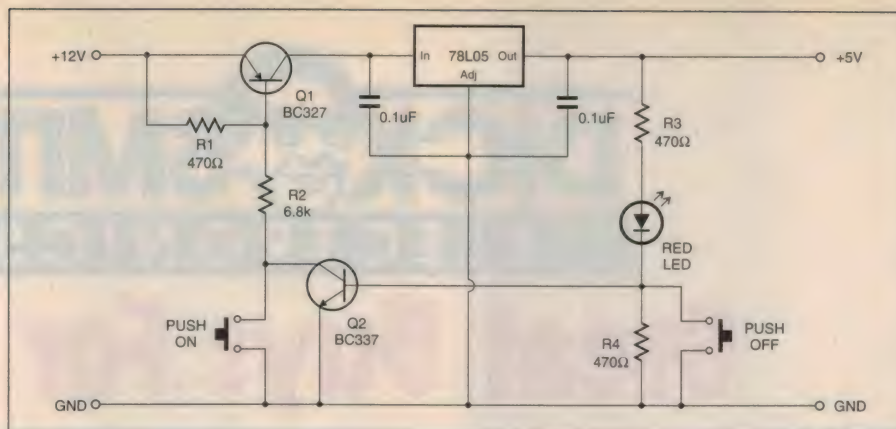


## Supply switching provides undervoltage lockout

Separate on and off buttons control the output of this simple 5V power supply, which was used to supply a 5V digital logic circuit from a 12V 1.2Ah gel cell battery. One useful feature of the design is that it prevents the battery from being completely discharged if the device being powered is accidentally left switched on.

When the 'on' button is pressed, Q1 is biased on and the regulator produces +5V on its output, and the LED turns on.

The voltage developed across resistor R4 turns on Q2, which latches Q1 on as the button is released. Pressing the off button shorts Q2's base to ground, causing both it and Q1 to switch off, interrupting the supply to the regulator. As



the gel cell battery discharges, its voltage starts to fall; if it ever falls to around 5-6V the voltage drop across R4 won't be enough to hold Q2 on, and thus the supply will shut down, protecting the

battery from over discharge.

Gerard La Rooy  
Christchurch, New Zealand \$40

**THIS MONTH'S PRIZEWINNER!**

## Calculating file download times

Have you been accessing the Internet and wanted to download a file — but not sure how long it might take? Not sure whether to tie up the phone line for too long?

Well, the above nomograph may help. There are many things that determine the time required to download a file over a communications line. The first parameters

are the speed of the line, that is the baud rate at which your line is operating, as well as the size of the file you are transferring. If the modem is operating at X baud (which is near enough to X bits of information per second), then the rate at which bytes of the file are transferred is typically X/10 bytes per second. This is because each byte (eight bits) of file information is coded for transmission in around 10 bits of line information. Then the time required for transferring B bytes of a file

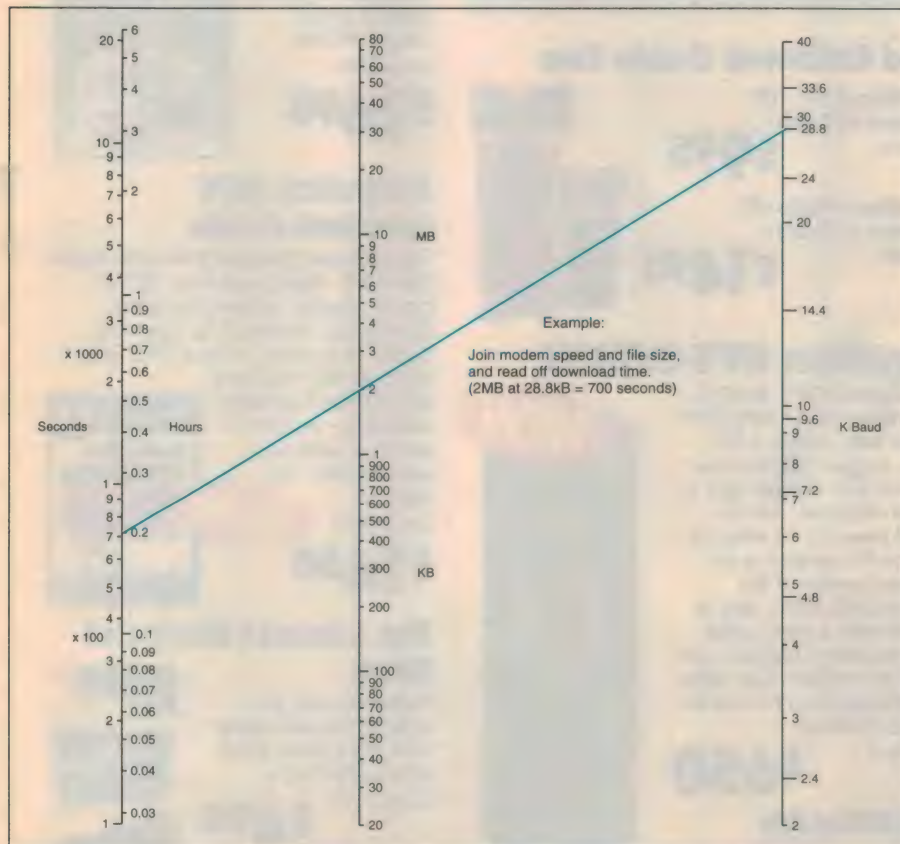
can be calculated as

$$T = B/(X/10) = 10.B/X$$

The accompanying nomograph implements this calculation without your having to do the arithmetic. Simply run a line from the modem baud rate through the file size to find the number of seconds the file will take to transfer.

Of course this is only a rough estimate of the transfer time, and other factors may have to be taken into account — perhaps the actual transfer rate isn't up to the full line speed because of loading on the host system, or the transfer protocol may use a compression technique which enhances the real transfer rate. Some protocols add extra information to the data to ensure transfer integrity, which slows the real transfer rate. But in any case, the nomograph will give you a rough estimate without your having to make all the calculations.

Dr Chris Andrews  
Chapel Hill, Qld \$30 ♦



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# DICK SMITH ELECTRONICS

## Great Buys For April

### Key Lock Tumblers

Add the element security to all your projects.

32 mm Cam.  
Cat L-5297

**\$495**



25 mm Cam.  
Cat L-5298

**\$495**

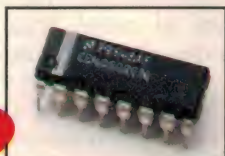


### 4060 14 Stage Binary Counter

An addition to our wide range of 4000 family devices, this is a 14-stage ripple-carry binary counter/divider and oscillator, including 10 buffered outputs plus an overriding asynchronous master reset input.

Cat Z-5660

**\$265**



**NEW**

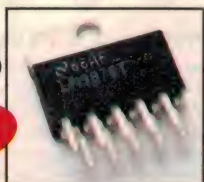
### Audio Power Amp LM3876T 50W RMS

56W continuous average output power into 8 Ohms

- 100W instantaneous peak output power
- 11-lead staggered pin T0-220 package
- 24V to 84V operating supply voltage
- Used in K-5606 50W amp module kit

Cat Z-6119

**\$1195**



**NEW**

SILICON CHIP

March '94

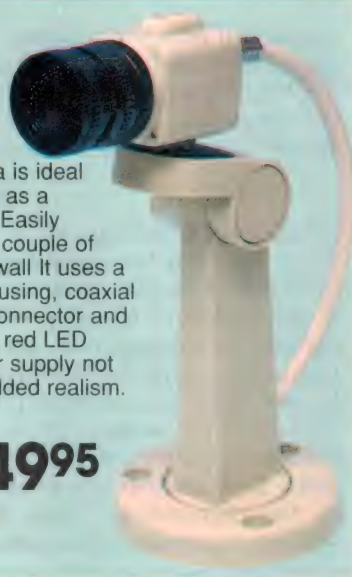
### Dummy Security Camera

This imitation security camera is ideal for small shops as a theft deterrent. Easily installed with a couple of screws in to a wall it uses a real camera housing, coaxial cable with 'F' connector and in-built flashing red LED (requires power supply not included) for added realism.

Cat L-5850

**\$4995**

**NEW**



### Mixed Coloured Cable Ties

Small 96mm Pack 100  
(10 colours x 10 pcs)  
Cat H-1959

**\$995**

Large 190mm Pack 100  
(10 colours x 10 pcs)  
Cat H-1961

**\$1495**



### Magellan GPS-3000XL

The Magellan GPS-3000XL is a compact hand held GPS receiver with a large LCD screen, rugged plastic case filled with dry nitrogen gas to exclude moisture, and an internal antenna for ease of use. The XL version is an enhanced model of the previous GPS-3000, and is supplied with a carry case, swivel mounting bracket, and DC power module. Can also be connected to a PC via an optional interface.

Cat D-3915

**\$650**



**NEW**

MAGELLAN  
GPS SYSTEMS

### 'Velcro' Cable Straps

Reusable cable ties that you can open or close to add or remove extra cables.

25 x 200 mm  
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 Dec '96/Jan '97

**LOOK what you get with this Dick Smith Electronics Kit** **\$229**

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|---|---|---|
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| <input checked="" type="checkbox"/> Remote control transmitter complete with case | <input checked="" type="checkbox"/> Phono preamp section              | <input checked="" type="checkbox"/> Components & hardware           |
| <input checked="" type="checkbox"/> Receiver unit with motorised potentiometer    | <input checked="" type="checkbox"/> Pre-punched chassis               | <input checked="" type="checkbox"/> MKT caps & metal film resistors |

### Performance Data

#### Frequency response

(line inputs, typical load)  
Direct mode: Unrestricted  
Bypass mode: 15Hz to 30kHz + 0/-1dB  
Tone mode: 20Hz to 20kHz +/-1dB with controls set to 'flat'

#### Total harmonic distortion

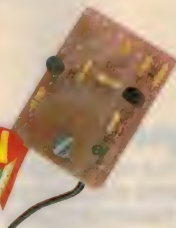
(20kHz bandwidth, typical load, at 1VRMS output)  
Direct mode: Unmeasurable  
Bypass mode: Less than 0.002%  
Tone mode: Less than 0.002%  
Input and output levels

#### Input and output levels


(Volume control at maximum, line inputs)  
Direct mode: 1V in for 1V out (max output: unrestricted)  
Bypass mode: 240mV in for 1V out (max output: 7V RMS)  
Tone mode: 240mV in for 1V out (max output: 7V RMS)

## Courtesy Light Extender

- Fit this project to your car and the courtesy light will stay on for an extended period after the door is closed, then fade out gradually.
- Cancels the delay extension when the car headlights are switched on.
- Suits lamp wiring with either +ve 12V or ground door switching.
- Extends light-on time by about 10 seconds.
- 3 wire connection to car.
- Installation can be made without cutting wires.
- Kit is supplied in shortform (PCB and components only).



**NEW**

 Apr '97


**\$990**

## Speaker Protector

- This simple circuit is designed to mate with most stereo amplifiers, music systems or car sound systems.
- Protects speakers from amp damage.
- Turn-on delay eliminates switch-on thumps.
- Circuit and PCB designed to take power sources from 9 or 12 volts DC or from +30V to +70 volts DC (ie using the internal power source of an existing amplifier).
- Kit supplied in shortform with all components, PCB and Hi-power relay.

Cat K-5414

**\$1950**

 Apr '97



**NEW**

## Kit Train Controller

- This easy to build train controller will give full, realistic control of your model trains.
- Full reverse to full forward speed.
- Inertia and brake switch automatic.
- Includes overload protection.
- Kit is supplied in shortform and includes only components, PCB and heatsink.
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Cat K-3029

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 Apr '97



**NEW**

Case & accessories shown not supplied.


## Analogue Multimeter

Build this very useful piece of test equipment and at the same time learn all about analogue multimeters. Has 19 ranges with 20K/V and includes features such as transistor check, mirrored scale and continuity. Kit is supplied complete with all components, hardware, PCB, comprehensive instructions, deluxe multimeter case and test leads which plug into recessed sockets for added safety. Instructions and parts will also be supplied to construct the transistor test adaptor lead.

Cat K-1050



**\$2960**

 Feb '97

## PC Driven Function Generator

This kit will save you hundreds of dollars over commercially available models. And it has greater features than most, with the ability to create virtually all waveforms from 0.25 Hz to beyond 100kHz. Using a novel application of direct digital synthesis this waveform generator is perfect for anyone who uses waveform for testing. Supplied complete with all components, hardware, PCB, case, transformer, pre-punched screened front panel and required software on a 3.5" disk.

Cat K 7348

**\$99**

 Mar '97



**Availability:** Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store.



# This Month's Specials!

## LCR Multimeter

3.5 digit (2000 count) display. Continuity and diode test. Transistor and capacitance. Frequency and duty cycle. Inductive and logic test. Input warning beeper. Auto power-off. Includes test leads and holster.

### Ranges:

DC volts: 200mV-1,000V  
AC volts: 200mV-750V  
AC/DC current: 20mV-20A  
Resistance: 200ohms-2,000Mohms  
Capacitance: 2nF-200uF  
Frequency: 2KHz-20KHz  
Inductance: 20mH-20H  
Cat Q 1559



**\$129**

**SAVE \$50**

## Digital Multimeter

This rugged 3.75-Digit (4000 count) digital multimeter is great for both field and workshop use, especially at this unbelievable price. It is shock resistant and comes with rubber holster for added protection. Features include continuity, diode and logic testing, peak hold and auto power off. Thermocouple probe included.

### Ranges:

DC Volts: 400mV, 4V, 40V, 400V, 1,000V  
AC Volts: 400mV, 4V, 40V, 400V, 750V  
DC Current: 400uA, 4mA, 40mA, 400mA, 20A  
AC Current: 400uA, 40mA, 400mA, 20A  
Resistance: 400, 4K, 40K, 400K, 4M, 40M ohms  
Frequency: 4KHz, 40KHz, 400KHz, 4,000KHz  
Temperature: Thermocouple supplied: -40 to 260 degrees C  
Unit's range: -50 to 1,300 degrees C  
Cat Q 1542



**\$129**

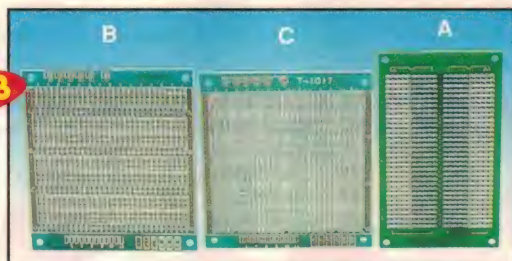
**SAVE \$50**

## Prototype Fibreglass PCBs

- A. 103 x 60mm double-sided printed circuit board. **\$495**  
Cat H-5611  
B. 95 x 85mm single-sided printed circuit board. **\$495**  
Cat H-5613

## Prototype Matrix PCB

- C. 95 x 85mm single-sided printed circuit board. **\$495**  
Cat H-5615



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## Antistatic Bags

Ideal for storing those delicate components. 3" x 5"

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**\$150** Pkt of 5

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## Digital Lux Meter

Perfect for photographers, video makers and photo labs. Quickly and accurately measures light up to 50,000 LUX over three ranges. Features auto zero, low battery indicator and comes complete with carry case. Requires 1 x 9 volt battery which gives 150-200 hours continuous use.

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## Electromagnetic Field Tester

This EMF Tester is a cost effective, hand-held instrument which will provide you with a quick, reliable and easy way to measure electromagnetic field radiation levels generated by power lines and cables, computer monitors, TV sets, video equipment and many similar devices. 3.5 digit (LCD) display.

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Band width: 30Hz to 300Hz.

Cat Q 1225



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# Security And Coms

## Central Door Locking System

Complete 4-door central locking system kit with hardware and electronic interface which converts standard door locks. Allows you to lock and unlock all doors from the driver's door. Can be connected to some Car Alarms and Engine Immobilisers to allow keyless entry to your vehicle.

Cat L-5421

**1 YEAR WARRANTY**



**\$99**

## Remote Control Car Alarm

This Australian made alarm allows for DIY installation with easy to follow instructions. Features a passive arming system which switches the alarm on if the owner forgets. All entry points are protected including the doors, boot and bonnet. Current sensing circuit detects voltage drop in the vehicles electrical system. Impact sensing system that warns away thieves. Also has optional central locking & immobilisation facilities. For professional installation ask our staff for more details.

Cat L-5418

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**\$259**

## Yaesu FRG-100 Communications Receiver

A highly sensitive receiver for the discerning shortwave listener, with extended receiver coverage of the 50kHz to 30MHz range in AM, SSB, CW and FM (optional) modes. The FRG-100 provides easy access to receiver functions, with receiver modes and the most-used features instantly accessible. A back-lit LCD screen shows 10Hz frequency resolution as well as an array of status indicators. New features include: user-programmable tuning steps, 50 tunable memories (which store frequency, mode and filter setting), sharp IF filters, a memory group scanning mode, and IF bandwidth selection by mode. Includes twin 12/24 hour clocks, a programmable on/off timer and 16 pre-programmed international shortwave bands. Ready for connection to an external 12V power source.

Cat D-2790

Not stocked in all stores, but may be ordered in.



**\$999**

## 120XLT Scanning Receiver

Provides nine-band VHF/UHF coverage including airband, 100 memories, and improved super fast scan and search features. Complete with NiCad battery pack, AC charger and detailed instructions.

Cat D-2752

**uniden \$299**

## Fanatics Frequency Register

This book features: Frequencies in across the Australia under one Australian National Listing plus all the old favourite emergency services frequencies. New sections include Airports, Airlines, Marine and Cellular Phones.

**\$380**



## Super Fast Scanning Receiver

The Uniden 220XLT provides 10-band VHF/UHF coverage including airband and 800MHz, 200 memories, and improved super fast scan and search features so you'll find signals faster. Scans up to 100 channels/sec or searches at 100 or 300 steps/sec. Complete with NiCad battery pack, AC charger and detailed instructions.

**2 YEAR WARRANTY**

Cat D-2755

**uniden \$369**

**SAVE \$70**

**SAVE \$100**

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## Passport To Worldband Radio 1997

Updated 1997 international shortwave radio broadcasting handbook which no shortwave radio listener should do without, especially suited for beginners looking for an easier way to tune into the world.

Cat B-2058

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## Construction project:

# INTERIOR LIGHT DELAY FOR CARS

Fit this little project to your car and the 'courtesy' light(s) will stay on for an extended period after the door is closed, then fade out gracefully. It's very small, low in cost, can be installed *without* cutting into the existing wiring, and can be configured to suit virtually any car.

by **ROB EVANS**

While there have been a number of courtesy lamp delay circuits published over the years, most of the existing designs seem to suffer from one form of practical disadvantage or another. Older designs often don't suit the wiring of current vehicles, and many of the newer circuits are either too complex and cumbersome, or suffer performance limitations due to their simplicity.

Based on these observations and what we considered as the important aspects of an interior light delay circuit, we formed a list of design goals for our new circuit:

- It should be very compact, so that can be easily hidden away in a vehicle's interior;
- It should suit all common types of car wiring;
- The interior lamp(s) should be *fully* on for the extended period, then fade out only at the very end;
- The circuit should dissipate little power, so that the unit won't get hot or need a cumbersome heatsink;
- Not surprisingly, the circuit should be very low in cost and use common off-the-shelf components;
- The unit should not draw any significant current while at idle, so as to preserve the state of the vehicle's battery;
- It must connect in parallel with the vehicle's wiring, so that it's easy to install or remove — that is, the existing wiring paths are not disturbed; and finally,
- It should offer a 'lights on' interlock facility, so that the extension period terminates immediately when the vehicle's lights are switched on.

As you have no doubt gathered, we were able to satisfy all of the above criteria with our new design. It uses a small (TO-220 style) power MOSFET as the switching device, and just a few common components for the sensing/delay

circuit. The final unit is very small indeed, dissipates little power, and can reliably detect the door switch activity with just three leads connected in parallel with the vehicle's wiring. A fourth lead is available for the (optional) car lights interlock.

Other than that, our new Interior Light Delay is easy to build (the parts should cost you less than \$10) and it can be assembled in two different ways on the same PCB, so as to suit different vehicle wiring.

## Circuit description

Since the unit can be built to suit vehicles with both possible types of door switch wiring, we've presented separate schematic diagrams for each version. As you can see, circuit A is for door switches that connect to +12V (battery positive) and circuit B is for those that switch to ground (battery negative or chassis).

Both circuits operate in the same basic way, where the courtesy light is activated by power MOSFET Q3, which is held on for an extended period by its drive circuitry based on Q1, Q2 and Q4 (version B). This in turn is triggered by the voltage change created by the switch/lamp combination, as the door is closed.

Note that while the schematics show just one courtesy lamp and switch combination, most vehicles will have at least four switches and several lamps wired in parallel with those shown.

Taking a closer look at circuit A first, you can see that the voltage at the junction of the lamp and door switch (point X) will normally be at ground potential (0V) when the door is closed (switch contacts open), and at +12V while the door is open (contacts closed). Under 'static' conditions (door closed, point X at 0V) then, capacitor C1 is held in a charged state via resistors R1 and R2, and Q1 is biased off.

When the door is subsequently opened, the now high level (+12V) at point X quickly discharges C1 into the +12V supply rail via diode D1. The circuit then remains in this state (Q1 is still off) while the door is open.

Once you are in the car and the door is closed, the falling voltage at point X is immediately coupled to the D1-side of C1, which biases Q1 hard on via limiting resistor R2. For the next hundred milliseconds or so, Q1 remains on while C1 charges via R2 and Q1's own base junction, which results in a short positive-going pulse at the collector of Q1.

This part of the circuit therefore operates as a one-shot or monostable, and its output is used as a trigger pulse for the remainder of the circuit. As you can see from the schematic, this positive-going pulse is applied directly to the anodes of both D2 and D3.

The trigger's high level at D3 will bias Q2 hard on through R5 and pull-down resistor R6, which in turn shorts the gate of MOSFET Q3 to ground for the period of the pulse. During this time the pulse will *also* quickly charge C2 via D2 and the low resistance path through the courtesy lamp. The voltage across C2 is then applied to R4 at the MOSFET gate, but as we have already established, the MOSFET is held off by Q2 for the period of the trigger pulse.

When Q1 then turns off at the end of the trigger period however, the MOSFET is 'enabled' as Q2 turns off, and the voltage stored in C2 is applied to the MOSFET gate via R4. The MOSFET then turns hard on, and the courtesy lamp is activated. Note that this occurs a hundred milliseconds or so (the trigger pulse period) after the car door has been closed, so in practice there will be a very short 'blink' as the lamp delay circuit takes over.

Since the MOSFET has a very high gate-to-source resistance, C2 will now



slowly discharge via R3, and as a result, holds the MOSFET on via R4 for an extended period of time. This is around 10 seconds in practice, and the MOSFET will only begin to turn off as its gate voltage drops below about three volts.

Note that while the MOSFET is fully saturated during most of the lamp hold-on period, it will slowly turn off in the last second or so as its gate voltage falls towards zero. This causes the lamp to fade out nicely at the end of the period, and as a result, the MOSFET will only dissipate significant power during this brief fade-out time.

There's also a relatively subtle but important advantage in having the lamp fade at the end, since the voltage at point X will slowly fall to zero — thereby preventing the circuit from re-triggering. Since a rapidly falling voltage at point X is used to trigger the circuit as the door is closed, a relatively low value was chosen for C1 (0.1uF) so that the slowly falling voltage at the end of the cycle will not be coupled through to Q1.

Other than that, note that as we have used a common (and low-cost) N-channel MOSFET, the circuit must maintain a positive gate-to-source voltage during the timing period. Since point X (the MOSFET's source) rises to 12V at the end of the short trigger pulse, this in turn means that the junction of C2 and R4 is actually at around 24V at this time — D2 is reverse biased, as you would expect.

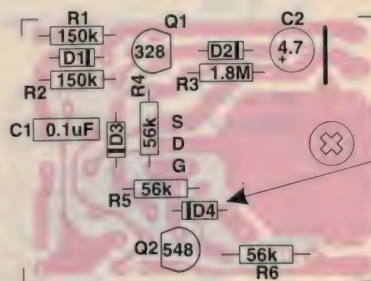
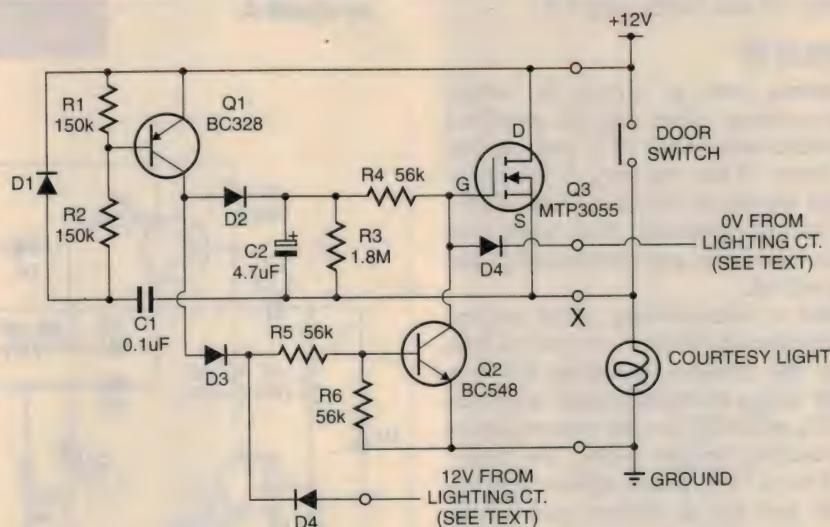
This is in fact one of the reasons why the one-shot circuit (Q1) is configured to generate a short pulse to trigger the following circuitry, rather than arranged to drive the MOSFET directly with an extended (say 10 second) pulse. In the latter case, the one-shot's output would have to rise to well above the supply rail voltage for an extended period, then of course, fall slowly for our fade-out effect — in short, this would require a much more complex circuit.

The remaining part of our circuit involves the action of D4, which terminates the timing period when the vehicle's lights are turned on. As you see from the schematic, D4 is shown in two alternative locations so that the circuit can be arranged to suit both types of vehicle wiring.

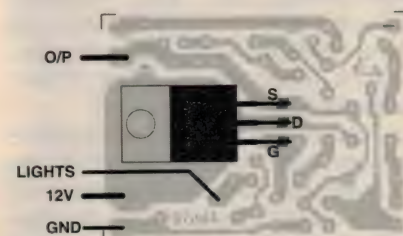
If the most convenient point to tap into the lighting circuit rises to +12V when the lights are activated, D4 shown in the lower part of the schematic is used. This effectively forms an OR gate with D3, and a high level at this point will simply bias Q1 on and therefore immediately



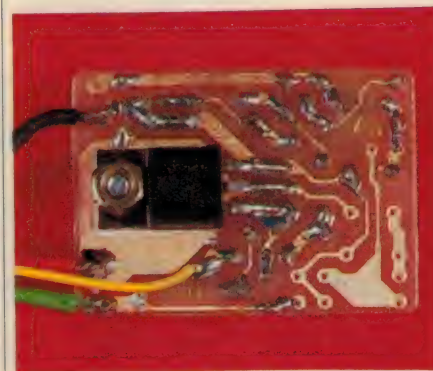
*A larger than life photo of the prototype for the 'circuit A' version, which suits vehicles with the courtesy lamps connected to ground. The schematic for circuit A (below) shows the lights-on interlock diode D4 at both locations.*



D4 position for 0V lighting circuit



*The switching MOSFET and connecting wires are fitted to the copper side of the PCB, as shown here. The component-side overlay diagram for circuit A (above) shows the alternative position - and orientation - for D4.*





## Interior Light Delay For Cars

turn the MOSFET off — C2 is discharged via R4, by the way.

The alternative position for diode D4, connected to the junction of the MOSFET gate and Q2's collector, is used when the tap-off point falls to ground when the lights are turned on — this might be where the lamps are tied to 12V, or if a relay coil is pulled to ground by the car light switch. Here, a low level will forward bias D4 and again, pull the MOSFET gate to a low level thereby turning off and discharging C2.

### Circuit B

Turning now to circuit B, which suits courtesy lamps that are switched to ground rather than 12V, you can see that most of the circuitry is the same as that shown in circuit A. The MOSFET is now connected from point X to ground however, and transistor Q4 has been added.

Since a door-closing event causes the voltage at point X to rise in this setup, the one-shot based on Q4 is a mirror image to that that used in circuit A (Q1), while Q1 is now used to invert the resulting trigger pulse. We therefore have a brief positive pulse applied to D2 and D3 as before, and C2 is charged to 12V while the MOSFET is held off by Q2.

Other than that, the MOSFET holds the lamp on in the same basic way as before. Its source remains at ground potential rather than moving with the lamp voltage, and both D4 connections perform as described above.

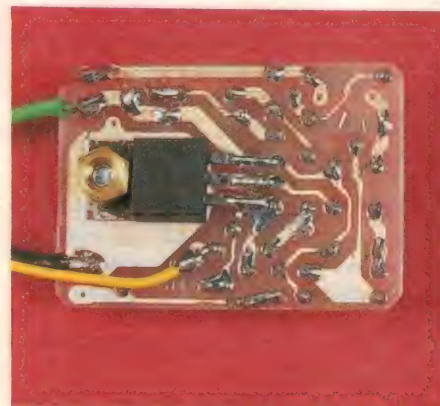
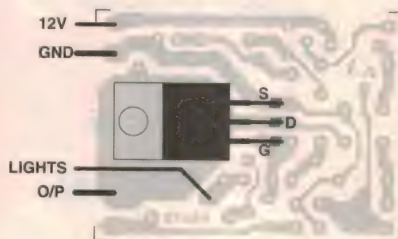
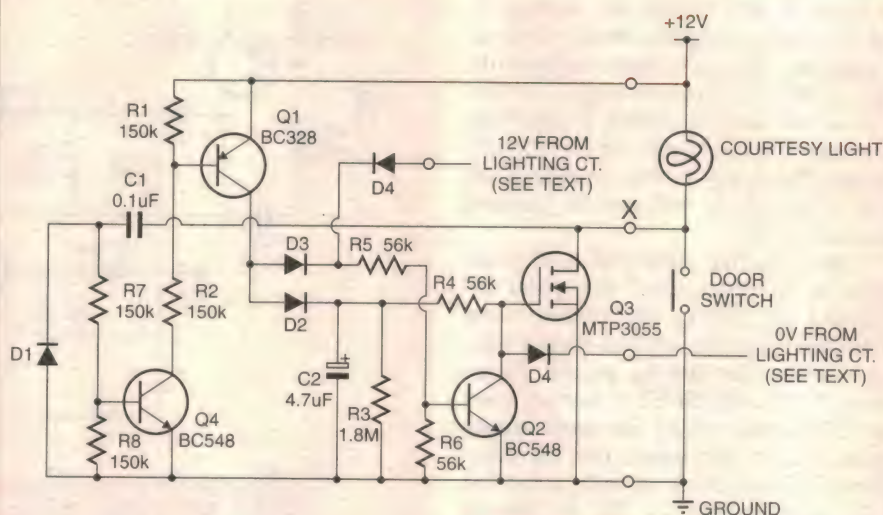
### Construction

The Courtesy Light Extender is very straightforward to put together, whichever version you elect to build. All of the components fit on one small printed circuit board (PCB) coded 97cd4, which measures just 41 x 31mm.

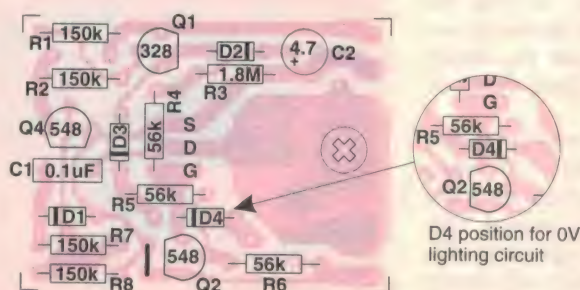
As you can see from the shots of the prototype units, the MTP3055 MOSFET is mounted on the copper side of the PCB along with the four wires that connect to the vehicle wiring. To make sure that there can be no confusion regarding the orientation of the MOSFET or connecting wires, we have elected to show component overlay diagrams for both sides of the PCB, as you can see.

Once you have completed a few checks on the vehicle — or examined its schematic diagram, if are fortunate enough to have one — and determined which version of the circuit you need

*The 'circuit B' version of the Interior light Delay uses an additional transistor (Q4) to make it compatible with lamps connected to the +12V supply. The actual circuit (shown below) uses the same MOSFET driver arrangement as circuit A.*



*Closely follow the copper-side (above) and component-side (below) overlay diagrams when assembling the PCB.*





to build, commence the construction while referring to the component overlay diagrams shown here.

As usual, start with the lowest profile components (resistors and the link) and work your way through to the larger parts. Take *particular* care with the orientation of the semiconductors and tantalum capacitor C2, and note that the link is near the top right-hand corner in circuit A and near the bottom of the board in circuit B.

The section of PCB copper around the MOSFET tag will act as a heatsink to a small degree (no pun intended), so you might like to scrape away any coating on the copper in that area and apply a small amount of heatsink compound, before the MOSFET is bolted in place. You will also need to take care with the alignment between the MOSFET legs and their matching PCB pads, and trim the legs to suit, as can be seen on the prototypes.

Once you are happy with the construction, attach lengths of hookup wire to the appropriate PCB pads — note that the connections are different for each version — and test the unit on the workbench or in the vehicle itself. As with all automotive projects, we strongly recommend that you test the unit before it's installed in the vehicle, as they can often be rather awkward to remove.

The completed unit will fit in standard plastic 35mm film container, or a modest length of large diameter heatshrink tubing, and we would recommend using penetrating crimp connectors to attach its leads to the vehicle wiring — these connectors are available from a number of electronics stores and are very convenient and effective.

## Testing & installation

To test (or install) the unit in the vehicle, you will first need to find the appropriate points in the wiring harness. While this should be fairly straightforward for the ground and +12V wires, finding the door switch or courtesy lamp wires may be a little more tricky. If you can't get hold of a vehicle schematic that includes colour codes, a bit of old fashioned probing should eventually bear fruit. Try using a sharp pin to penetrate the insulation of likely wires, then check the voltage at the pin with a lamp or multimeter.

Once the connection points are determined, attach the 12V, OUTPUT and GND leads to the vehicle wiring, but not the LIGHTS wire at this stage — a problem here will only confuse the issue. *Make sure that you have built the correct circuit version for your car wiring*

## PARTS LIST

### Resistors

R1,2,7,8 150k  
R3 1.8M  
R4,5,6 56k

### Capacitors

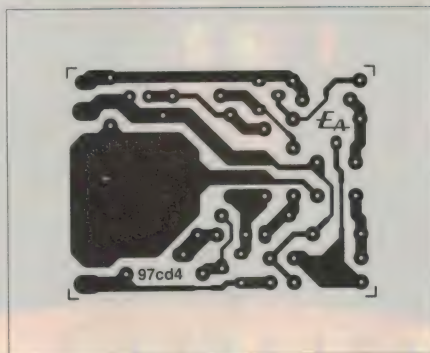
C1 0.1uF MKT  
C2 4.7uF 16VW tantalum

### Semiconductors

Q1 BC328 PNP transistor  
Q2,4 BC548 NPN transistor  
Q3 MTP3055 N-channel power MOSFET  
D1,2,3,4 1N914 diode

### Miscellaneous

PCB coded 97cd4, 41mm x 31mm; hookup wire; FET mounting bolt.



*The actual size artwork for the unit's PCB, as viewed from the copper side.*

*before making these connections, as the incorrect version may cause a short across the 12V supply!*

If the circuit performs as expected, connect the LIGHTS wire and check its effect on the operation. Then hide the unit away in some convenient location, such as under the instrument panel.

On the other hand, if the circuit does not respond to your initial tests, try briefly shorting the junction of D2 and D3 to 12V. This effectively bypasses the one-shot section and cuts the circuit in half — in the troubleshooting sense. The lamp should remain off while the shorting wire is held to 12V, and then come on for the extended period when the lead is removed.

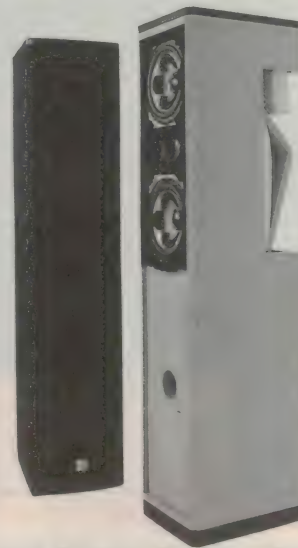
If the circuit passes this test, suspect the one-shot circuit, and in particular the orientation of Q1, Q4 (version B) and D1. A total lack of response may indicate an orientation problem with D2 and C2 (by now possibly deceased), while if the lamp comes on as soon as the test link is connected to 12V, check the section based on Q2 and D3. And by the way, double check that the PCB link is correctly fitted for your version. ♦

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*Cutaway showing internals of new VAF DC-X*

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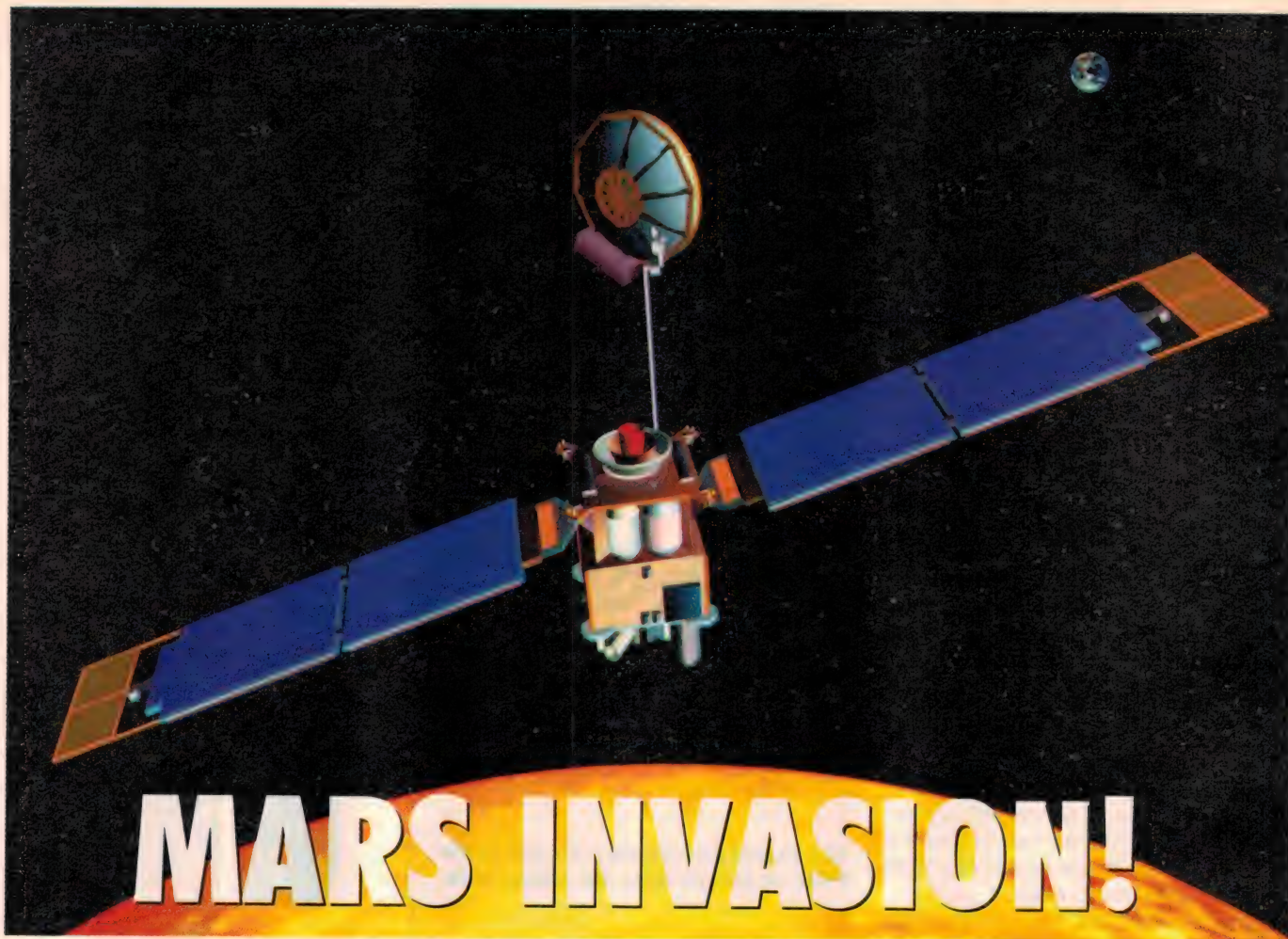
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# MARS INVASION!

Currently on its way to Mars is the first of a whole series of new space missions to study the 'red planet' in greater detail: the Mars Global Surveyor or 'MGS'. Launched successfully in November last year, it's planned to enter Mars orbit around September and start sending back a veritable torrent of information about the planet for the next couple of years. Here's an idea of the instruments it's fitted with, and what they do.

by KATE DOOLAN

In August 1993, scientists from all over the world were anxiously waiting the arrival of the Mars Observer spacecraft into Martian orbit. But their wait was to be in vain, when the spacecraft mysteriously lost communication with Earth and was never heard from again.

Three years later another wait began, although this time around it will not be one spacecraft travelling to Mars but a series — in what will be a biannual event, until at least 2005. With the recent revelations that there may have been life on Mars as recently as 3.6 billion years ago, there is a renewed interest in robot Martian exploration that may lead the way to an eventual human presence on the red planet.

In 1996 alone, three spacecraft — Mars Global Surveyor, Mars 96 and Mars Pathfinder — were launched to

Mars in a period of one month. Happily for planetary scientists, this is just the beginning of the robot invasion of Mars. In addition lessons have been learnt from highly expensive Mars spacecraft of the past, allowing a new sort of technology to be developed.

The Mars Observer spacecraft was launched in September 1992 and was scheduled to be inserted into Martian orbit on 24 August 1993. However three days earlier, ground controllers at the Jet Propulsion Laboratory (JPL) in Pasadena, California sent a command to the spacecraft to turn off its transmitter, as a precaution whilst the thruster fuel tanks were pressurised. The spacecraft was then supposed to start automatically transmitting 15 minutes later, but nothing was heard from Mars Observer.

Attempts were made to contact the

spacecraft, but all of them were doomed to failure. Mars Observer was programmed to reorientate itself to the Sun and switch to a backup receiver during any five-day period, but again nothing happened.

Commands were sent to the spacecraft all through September 1993 without success. On September 3, 1993, National Aeronautics and Space Administration (NASA) chief Dan Goldin appointed a six person panel headed by Dr Tim Coffey of the Naval Research Laboratory to investigate the Mars Observer disappearance.

In a report made public in January 1994, the panel found that there were design flaws in the Mars Observer spacecraft and the most likely cause of failure was the slow leaking of nitrogen tetroxide into the propulsion system



pipes during the flight to Mars. Weaknesses were also found in software. Also cited was a lack of backup equipment, workmanship errors and management problems.

## Mars Surveyors

In February 1994, NASA proposed the Mars Surveyor exploration program which would be designed to launch an orbiting spacecraft and a lander to the red planet during each two year launch window over the next decade. The first of these spacecraft, the Mars Environmental Surveyor (MESUR) Pathfinder, had received Congressional funding in October 1993. The second of

these spacecraft, the Mars Geoscience Orbiter was proposed in President Bill Clinton's Financial Year 1995 budget and received approval in October 1994.

NASA and JPL conducted an aerospace industry-wide contest to select a prime contractor for the Mars Geoscience Orbiter, which had recently been renamed the Mars Global Surveyor (MGS). Performance objectives called for a low mass, polar orbiting spacecraft that would cost under US\$155 million dollars. In July 1994, Martin Marietta Technologies of Denver, Colorado was announced as the winner. To keep the spacecraft light, graphite composite material would be used instead of alu-

minium. To use less fuel, the MGS would use a technique known as aerobraking to slow the spacecraft and then place it into a proper orbit around Mars.

The MGS was one of the first projects announced under Dan Goldin's 'better, faster and cheaper' program. This was a change from billion-dollar planetary spacecraft that took years to design, launch and travel to their destination. An example of the old way of doing things was the Galileo spacecraft, which took 18 years from approval to arrival at Jupiter — with a cost of over a billion dollars.

The Mars Global Surveyor (MGS) spacecraft is three metres tall and weighs 1060 kilograms, which includes the fuel and scientific instruments. The bus (or main body) of the spacecraft measures 1.5 by 1.5 metres and is 12 metres across when the solar panels are fully deployed. The high-gain antenna which will be deployed later in the flight is 10 metres in height and is deployed on a 2m-long boom.

To save money, most of the MGS electronics and scientific instruments were 'left over' units from the Mars Observer project. The spacecraft design also incorporates new hardware in the form of radio transmitters, propulsion systems, solid state recorders and composite material bus structure.

Mars Global Surveyor will orbit Mars so that one side of the spacecraft bus (called the nadir deck) always faces the planet's surface. Of the six scientific instruments aboard, four — the Mars Orbiter Laser Altimeter, the Mars Orbiter Camera, the Electron Reflectometer and the Thermal Emission Spectrometer — are attached to the nadir deck, along with the Mars Relay Radio System. The magnetometer sensors are attached to the ends of the solar arrays.

The bus has two solar array 'wings' and a boom mounted high-gain antenna. The solar arrays, which are always pointed at the Sun, provide 980 watts of electricity for operating the spacecraft's electronics equipment and for charging the nickel-hydrogen batteries. The batteries will be providing power when the spacecraft is mapping the dark side of Mars.

The high-gain antenna is mounted on the end of a boom, so its view of the Earth will not be blocked by the solar arrays as the spacecraft orbits Mars. Measuring 1.5m in diameter, the steerable antenna will be pointed at Earth even though the spacecraft's position will be continuously adjusted during mapping to keep the nadir deck pointed



*Jet Propulsion Laboratory workers were installing protective thermal blankets on the Mars Global Surveyor in KSC's Payload Hazardous Servicing Facility-2 when this picture was taken before its launch. (Courtesy NASA)*



## Mars Invasion!

at Mars. The spacecraft's radio system, which includes the high-gain antenna, also functions as a scientific instrument.

To maintain operating temperatures, most of the exposed spacecraft including the scientific instruments are wrapped in gold Mylar thermal blankets.

### Surveyor objectives

The goal of the Mars Global Surveyor program is to provide a detailed global map of Mars that will allow scientists to study its climate, geology and interior. Some of the key scientific objectives include:

- Characterising the surface features

and geological processes on Mars;

- Determining the global topography, planet shape and gravitational field;
- Monitoring global weather and thermal structure of the atmosphere; and
- Determining the composition, distribution and physical properties of surface minerals, rocks and ice.

Scientists hope to answer questions relating to Mars' early atmosphere and the dramatic climate changes which turned the planet into a 'deep freeze'. All the ingredients for life including water exist on Mars, yet the surface of the planet is bone dry and thought to be devoid of life.

Water is essential to the understand-

ing of geological processes and climate change. However water cannot exist in liquid form at the low atmospheric pressures that currently exist on the Martian surface, as it turns into ice or water vapour.

In the past, spacecraft have photographed large channels across the Martian surface that indicated that they were carved by running water. One of the questions scientists want to know is where the water went, as only a small fraction is known to exist in the northern polar cap and in the atmosphere. Some of the water may have escaped into space, but it is widely believed that most of it remained on the planet.

Also a mystery is the origin and evolution of Mars. Thought to have formed 4.6 billion years ago, Mars has two distinct hemispheres divided by the equator. The southern hemisphere is badly battered, which may have been the result of an intense bombardment as the planet was forming. Other regions of Mars may be plains of volcanic lava. Geologic activity in the northern hemisphere created huge and isolated volcanos. A canyon below the Martian equator named Valles Marineris stretches 5000 kilometres across the planet's surface, and may have flooded regions of Mars hundreds of millions of years ago.

### Six instruments

The Mars Global Surveyor carries a complement of six scientific instruments. They are:

**1. Mars Orbiter Laser Altimeter (MOLA).** This is an experiment that will measure the height of Martian surface features. A laser will fire pulses of infrared light 10 times each second, striking a 160-metre area on the surface. By measuring the length of time it takes for the light to return to the spacecraft, scientists can determine the distance to the planet's surface. Data from the MOLA will give scientists elevation maps precise to within 30m, from which they will be able to construct detailed topographic maps.

**2. The Mars Orbiter Camera (MOC).** This is unlike cameras on previous planetary spacecraft, which take conventional snapshot exposures. Instead, the MOC uses a 'pushbroom' technique that builds up a long ribbon-like image as the spacecraft passes over the planet.

The MOC will provide low resolution global coverage of Mars every day, collecting through red and blue filters. It will also obtain medium and high resolution images of selected areas. The



*This picture shows the MGS/upper stage booster assembly being encased in the Delta II payload fairing at Launch Complex 17A at Cape Canaveral, a few days before launching. (Courtesy NASA)*



wide angle lens will be used to accumulate data for a daily weather map of the planet, showing surface features and clouds at a resolution of 7.5km. The narrow angle lens will obtain images of surface features at a resolution of 2 - 3m. These images will be sharp enough to show small geologic features such as rocks and even the Viking landers that have been on Mars since 1976.

**3. The Electron Reflectometer/Magnetometer.** This will search for evidence of a planetary magnetic field, and measure its strength if one does exist. These measurements will be providing critical tests for current speculation about the evolution and history of Mars. The instrument will also be scanning the surface to detect the remnants of an ancient magnetic field, which would provide clues to the planet's past where the magnetic field may have been stronger due to Mars' higher internal temperature.

**4. The Thermal Emission Spectrometer (TES).** This will analyse infrared radiation from the surface of Mars. From these measurements, scientists can determine important properties of the rocks and soils that make up the Martian surface. This should answer questions such as how hot and cold they get during the cycles of day and night; how well they transmit heat; the distribution of rock and grain sizes and the amount of the surface covered by large rocks and boulders.

Scientists will also be able to identify minerals in sand dunes and solid rock, which will help to understand the evolution of Martian rock over millions of years. The TES will also provide information about the Martian atmosphere, especially the location and nature of short lived clouds and dust.

**5. The Radio Science (RS) Investigation.** This will use data provided by the spacecraft's telecommunications systems, high-gain antenna and an onboard ultra-stable oscillator to map variations in the gravity field, by observing where the spacecraft speeds up and slows down in its orbits around Mars. From these observations, a precise map of the gravity field can be constructed and related to the structure of the planet. Scientists can also study how radio waves are distorted as they pass through Mars' atmosphere, to measure the temperature and pressure.

**6. The Mars Relay Radio System (MR).** This is a radio receiver/transmitter that was supplied to the MGS project by the Centre National d'Etudes Spatiales (CNES or French Space Agency), which was to support the Russian Mars 96 mission. The MR was

*Observers at a safe distance watch the launch of the Mars Global Surveyor, which went off without a hitch at Cape Canaveral on November 7. It's due to reach Mars orbit this September. (Courtesy NASA)*



to periodically receive and relay data from instrument packages deployed to the Martian surface by the Mars 96 orbiter which was to be working in parallel to receive and relay additional data from the instrument packages. Data that was to be returned to the Mars Global Surveyor would have been stored in the large solid state memory of the spacecraft's camera, where it would have been processed and returned to Earth.

Now that the Mars Relay Radio System is not required for Mars 96 support, it will be used to provide multiple years of in orbit communications relay for future Mars missions.

### Launch time

After arriving at the Kennedy Space Centre in Florida on 14 August 1996, the Mars Global Surveyor was transported to the Payload Hazardous Servicing Facility where it was tested. The final assembly of the spacecraft also took place there. This included installing thermal blanketing. After that, the propulsion system was tested, fuel then was loaded into the spacecraft and there was a final weigh-in to ensure that

the MGS was not too heavy for launch. After the fuelling was completed, the scientific instruments were inspected and cleaned.

On 22 October 1996, the Mars Global Surveyor was driven out to Space Launch Complex 17A and hoisted onto the top of the Delta II 7225A launch vehicle. The Delta II, one of the most reliable launch vehicles ever built, consists of a first stage liquid rocket, a second stage liquid rocket, nine solid rocket motors attached to the second stage and third stage solid rocket that is connected to the spacecraft. The whole launch vehicle was 40m tall and weighed over 231 tonnes.

Once the spacecraft was on the launch pad, it went through another round of testing to ensure that it had survived the trip to Launch Complex 17A. Before the rocket nose fairing was installed, items such as protective components were removed from MGS. On 31 October, both the launch vehicle and spacecraft were ready for flight.

The first launch attempt scheduled for November 6 was postponed due to strong winds and heavy cloud cover.



## Mars Invasion!

However all went well the following day and at 12:00pm (local time) on November 7, 1996, Mars Global Surveyor was successfully launched. After launch, the spacecraft was boosted to an altitude of 115km. Ten minutes after launch, MGS was sent into a parking orbit of 185km until it reached a position over the Indian Ocean. At that time, the Delta second stage restarted and fired to raise the high point of the parking orbit.

Small rockets were used to spin up the Delta's third stage and spacecraft to 60 revolutions per minute. After separation from the second stage, the third stage engine was ignited. The third stage then fired for 87 seconds to complete the trans-Martian burn which sent the spacecraft on its way to Mars. Once the burn was completed and before the third stage was jettisoned, a 'yo-yo cable' device was deployed to de-spin the spacecraft.

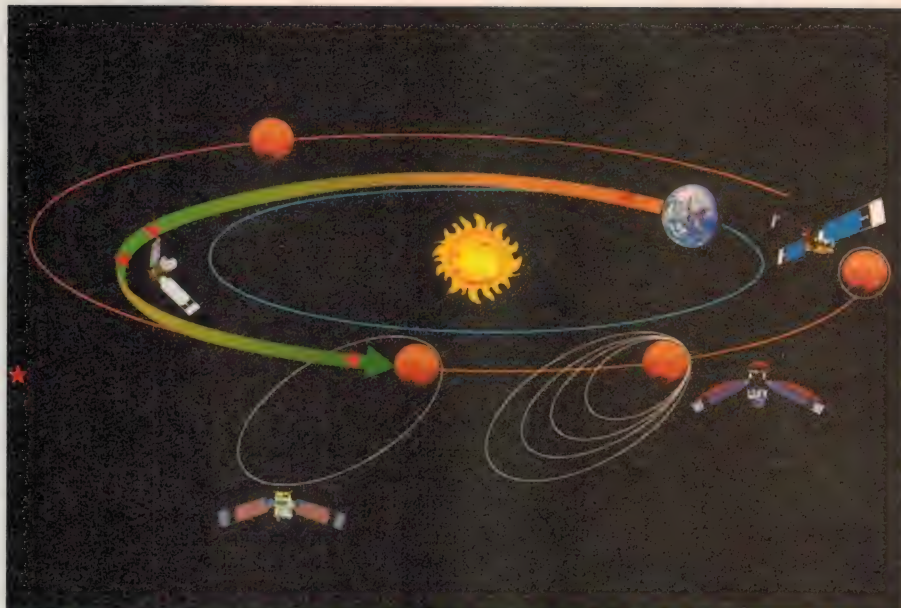
Once separation from the third stage took place, the spacecraft's solar arrays were swept forward 30° and then it slowed to a spin rate of one revolution every 100 minutes. Twenty five minutes after the trans-Martian burn, the first signal from MGS was received by the Deep Space Network (DSN) station at Tidbinbilla in the ACT.

The Mars Global Surveyor will take 302 days to reach Mars on a path known as the Type 2 trajectory. A Type 2 trajectory takes a spacecraft more than 180° around the Sun and is a slower way to reach Mars. However, because the spacecraft is travelling at a lower velocity, it requires less propellant to slow it down on arrival at its destination.

Seven days after launch, the spacecraft's propellant tanks were pressurised. On 21 November 1996, the MGS fired its main engine in the first of four trajectory correction manoeuvres to fine tune its flight path. The day after, ground controllers powered up the scientific instruments — with the Mars Orbiter Camera being used to take images of the Earth for calibration purposes.

During the first part of its flight, which is called the 'inner cruise', the MGS will be communicating with Earth via its broad beam low-gain antenna. The high-gain antenna is stowed in a fixed orientation during the cruise.

The outer cruise begins when the spacecraft switches from the low-gain to the high-gain antenna for communication. The exact time when the switchover becomes feasible depends



**An artist's impression of the trajectory that the Mars Global Surveyor spacecraft is following, on its 300-day journey to the Red Planet. It will travel 750 million kilometres. (Courtesy NASA)**

on the angle between the Sun and the Earth as seen from the spacecraft. When this angle falls to a level low enough, the solar panels will be able to collect sufficient power while the high-gain antenna is being pointed at Earth.

Another three trajectory correction manoeuvres are planned during the cruise period. Most of the outer cruise will be relatively quiet, with little going on. The vast majority of the happenings will involve acquiring tracking and navigation data to support the remaining trajectory correction manoeuvres. During the last month of approach to Mars, the focus will be on final targeting of the spacecraft to the proper aim point for orbital insertion.

Mars Global Surveyor will perform an attitude correction manoeuvre once it reaches Mars orbit in September 1997, to turn the spacecraft's main engine towards the direction of its motion. The spacecraft will then fire its 600-newton main engine for approximately 20 - 25 seconds, to slow down. By completion of this 'orbital insertion burn', the spacecraft will have slowed down by 1000 metres per second with respect to Mars.

Because of mass limits imposed by the lifting capabilities of the Delta II launch vehicle, the Mars Global Surveyor does not carry enough propellant to be able to insert itself into its final low altitude mapping orbit with an engine firing. As a result, MGS will use the innovative technique known as 'aer-

obraking'. This technique was used with great success by the Magellan spacecraft during its mapping of Venus, to trim its highly elliptical orbit down to the altitudes for the mapping orbit.

During each of its orbits after Martian arrival, the MGS will pass through the upper fringes of the planet's atmosphere each time it reaches periapsis — which is the point in its orbit closest to the planet. Friction from the atmosphere will cause the spacecraft to be dragged closer to the surface, losing some of its momentum during each orbit. Loss of momentum will also lower the apoapsis (the point in its orbit furthest from Mars).

Aerobraking will take place over four months beginning with the initial 'walk in' phase. The spacecraft's apoapsis and periapsis will be gradually adjusted over the months as more is learned about the density of the Martian atmosphere. As MGS continues to drop into a lower orbit, scientists will be able to measure the atmosphere density and its variations from one orbit to the next.

In addition, the spacecraft is scheduled to fire its thrusters four times during the aerobraking phase. The final mapping orbit will be nearly circular at 350 by 410 kilometres, or an average of 378 kilometres above the planet's surface. Once mapping orbit has been achieved and is in place, the spacecraft systems will be deployed and the scientific payload will be checked out.

Once in its mapping orbit, the Mars



Global Surveyor will complete one orbit of Mars every two hours with each new orbit bringing the spacecraft over a different area of the planet. The primary mapping mission is planned to begin on 15 March 1998 and last until 31 January 2000, which is a period of one Martian year or 687 Earth days.

The spacecraft will transmit its recorded data back to Earth every day during a single 10-hour tracking pass by the antennas of NASA's Deep Space Network. During mapping operations, MGS will be returning more than 600 billion bits of scientific data to Earth. To place this in context, it is equivalent to the total amount of data returned by all planetary spacecraft since the beginning of planetary exploration, with the exception of the Magellan mission to Venus.

By the time that global mapping has been completed, the Mars Global Surveyor will have obtained an extensive record of the nature and behaviour of the Martian surface, atmosphere and interior. Such a record will be essential in the planning of more specialised flights that will involve robots, scientific stations sent to the surface, sample return missions and maybe human landings. It is hoped that a sample return mission will be launched in either 2003 or 2005. Due to political considerations and cost, it is not known when humans will land on Mars.

Throughout the two years of the MGS's mapping mission, scientists will have science operation planning computers at their home institutions. All are electronically connected to the project database at JPL. This will

enable scientists to have direct involvement in mission operations.

These computers are equipped with software that will allow the science teams to remotely initiate most of the commands required by their scientific instruments to conduct the experiments as they desire. The teams will also be able to access the raw data within hours of its arrival on Earth. This automated operation will permit 'quick look' science data and let scientific investigators monitor the performance and health of their instruments.

Most images returned as well as other data will be immediately available to the public via the Internet. The major home site for Mars Global Surveyor is <http://mgs-www.jpl.nasa.gov>. Don't forget though, that MGS doesn't arrive at Mars until September 1997 — so it would currently be a waste of time to check for new Martian images!

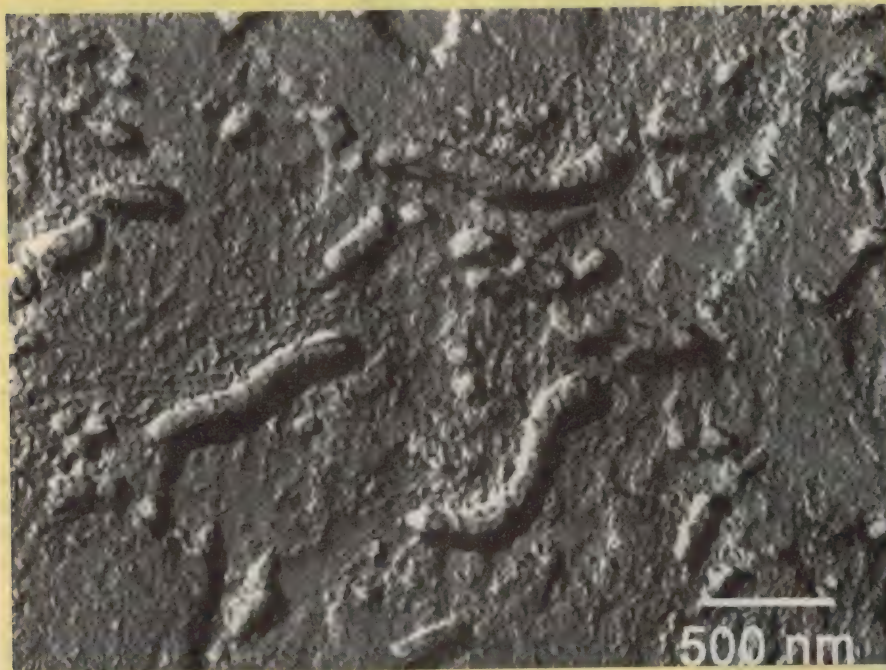
After a period of data validation, both raw and processed science data along with supplementary documentation and processing documentation will be transferred to NASA's Planetary Data System archive for access and use by the scientific community as well as interested members of the general public.

Control and operation of the Mars Global Surveyor is being performed by a team of engineers located at the Jet Propulsion Laboratory and at Lockheed Martin Astronautics Inc in Denver, Colorado. Engineers in Denver, who are electronically linked to JPL, provide monitoring and analysis of the spacecraft based upon telemetry received through Deep Space Network stations in Spain, California and Australia. The engineering team have also developed the sequence of commands that are being sent to the spacecraft via the DSN. This electronic networking also eliminates the cost of relocating mission operation team members during the MGS mission.

With its successful launch, the Mars Global Surveyor has started what will hopefully be a new era in Martian exploration with the possibility that one day we may see people on the Red Planet.

In closing, the author wishes to thank Colin Burgess and Debbie Dodds of the Johnson Space Centre; Dr Ken Edgett of Arizona State University; Mary Hardin of the Jet Propulsion Laboratory; Louis Kourtidis; and Margaret Persinger of the Kennedy Space Center, for their assistance in the preparation of this article. All photos shown are courtesy of NASA and Lockheed Martin. ♦

## Life on Mars?



One of the great enduring myths about the planet Mars has always been the possible existence of Martians. Until the advent of the Space Age, many people thought that Mars had harboured life of one sort or another.

With the beginning of the Space Age, spacecraft were sent to Mars, where they found it to be a dry and inhospitable sort of place with no signs of life.

It therefore came as some shock when NASA held a press conference on 7 August 1996, announcing that evidence had been found strongly suggesting that primitive life may have existed on Mars more than 3.6 billion years ago.

A team of NASA scientists found the first organic molecules of Martian origin in a meteorite that fell to Earth 13,000 years ago and was discovered in the Antarctica during December 1984. The largest possible fossils are less than 1/100th the diameter of a human hair.

While exciting, the evidence is not conclusive and more research will need to be done both here on Earth and on Mars, to determine whether Martian life did actually exist at one time or another.

The paper detailing the discovery was in the 16 August issue of the magazine *Science*, and can be found on the Internet under: <http://www.hq.nasa.gov>.



**NSW businessman discovers opportunity:**

# "NOBODY KNOWS HOW TO FIX THEM!"

The development of electronic engine and exhaust analysers has revolutionised the car repair industry — but who fixes those expensive analysers when *they* need repairing? A businessman on the north coast of NSW has come up with an interesting franchise operation, designed to help auto technicians save money while providing local electronics engineers with interesting and remunerative work in their spare time...

An unusual area of electronics is the subject of a franchise operation being set up by NSW electronics businessman Tim Polhill, who has been repairing engine and exhaust analysers (together with wheel balancers and aligners) around the Newcastle and Hunter region since February 1991.

As most garage mechanics these days are unable to afford the tens of thousands of dollars for the latest analysers, there is

a proliferation of older electronic instruments in nearly every garage workshop — generally pushed into one corner because the proprietor either cannot afford to have it repaired, or more commonly because they believe that "nobody knows how to fix them". This is a pity, because an analyser is a very valuable diagnostic tool, particularly in today's workshops, and often still capable of earning a lot of money.

During one of his many service trips to Dubbo from his workshop in Salamander Bay, Tim realised the problem facing mechanics around the more remote areas of Australia was in getting their electronic equipment repaired — without paying the very high travel expenses of service engineers coming up from Sydney or other capital cities. He realised that this provided an excellent business opportunity, and one that would readily lend itself to franchising.

As a result, Tim is now enrolling working electronics engineers in country towns, who could fit some extra service time into their working day without affecting their main business, in a franchise operation that is extremely interesting. He claims it also has the potential to be very rewarding. The name adopted for the franchise is appropriate: 'Garatronics'.

To support his franchisees, he supplies many service manuals and circuit diagrams of all the most common instruments found in garages today. He also conducts training sessions at his workshop in Salamander Bay — backed by telephone helplines from himself and a colleague, Bill Johns, who has over 20 years hands-on experience in garage electronics.

According to Mr Polhill there are many other benefits to be had from one of his franchisees, such as buying, selling and renting good used equipment as well as handling new equipment sales — on the basis that the person who sells the equipment can install it and is also 'just round the corner' when help is needed.

A twice-yearly newsletter is sent out to all customers and backed up by national magazine advertising.

Mr Polhill says this service is being welcomed with 'open arms' by the auto repair industry, and he looks forward to meeting any electronics engineer who would like to diversify and improve his business without affecting his main income. Naturally there are some costs involved in setting up each franchise, but he suggests this would be recouped in a fairly short time as each franchisee would have his own exclusive area and friendly help from other franchisees from their own area. That's one of the advantages of franchising, he notes.

For further information, contact him at Tim Polhill Electronics, 12 Starboard Close, Salamander Bay 2317; phone/fax (049) 82 0524, or mobile on (018) 493 149. ♦



**Businessman Tim Polhill in his workshop, with a reconditioned engine analyser. He's found that many garage owners have such equipment in need of repair — an excellent opportunity for those with the right skills.**





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**A reader explains how to get**

# MORE FREQUENCIES FROM THE ARB/FN GEN

Shortly after our first article describing the PC-Driven Arbitrary & Function Generator appeared in the December issue, we received an e-mail from the author of this article. In it he explained that despite what we'd thought, our Generator *wasn't* limited to a relatively poor frequency resolution near the top end of its range — with the right software technique, it would generate many more frequencies. Would we be interested? We certainly were, and here's the article we encouraged him to write...

by **BENJAMIN LOW**

In the first of his articles describing the PC-Driven Arbitrary & Function Generator, Jim Rowe suggested that "there are no free lunches", and that coarse frequency settings at the high end were one of the penalties incurred by using the 'poor man's DDS' waveform generation technique. I'm pleased to be able to advise that by using an improved software algorithm, it's possible to overcome this limitation quite elegantly, and allow the generator to produce many more closely-spaced frequencies. So perhaps, figuratively speaking at least, lunch is today on me!

The frequency resolution of the original sample calculation technique is limited due to the small waveform length (in samples), and the inability to get fractional samples. To use the example from the December article, for a 50kHz signal there are only 40 samples. To get say 50.001kHz would require 39.9992... samples, which is not directly possible; we can only drop to 39 samples.

However instead of using a single period, we can repeat the waveform a number of times to 'soften' the integer nature of the number of samples.

For example, suppose we require 40.25 samples/period (at 0.5us/sample = 49.6894kHz). In this case we can simply repeat the waveform say four times and use 161 samples. Then we calculate the waveform over four periods rather than just one.

Similarly if we need say 40.1 samples/period, to produce 49.8753kHz, we could calculate the waveform so that 10 periods use 401 samples. Given a large enough RAM size, any given waveform period can be achieved; or looking at it another way, with a fixed 32KB RAM size we can generate a much larger number of closely-spaced frequencies at the top end, by using

this multi-period approach.

The above ideas can be expressed as a set of four equations. The exact number of samples (a real number) is given by:

$$N = \frac{f_{\text{clock}}}{f_{\text{desired}}} \quad (1)$$

Now we want to fit the maximum number of waveform periods, each of size N, into the static RAM. So the number of repetitions (a nonzero integer) are given by:

$$K = \left\lfloor \frac{\text{RAMSIZE}}{N} \right\rfloor \quad (2)$$

Where the delimiter 'brackets' mean 'round towards zero.

The total waveform length for K periods is given by:

$$L = \lfloor N \times K \rfloor \quad (3)$$

The 'average' number of samples per period is thus K/L, and we then have the resultant output frequency (a real number) given by:

$$f_{\text{out}} = f_{\text{clock}} \times \frac{K}{L} \quad (4)$$

An example will illustrate the above. Say we want an output frequency of 12,345 Hz. Fig.1 shows the calculations.

$$N = \frac{f_{\text{clock}}}{f_{\text{desired}}} = \frac{2 \text{ MHz}}{12345 \text{ Hz}} = 162.00891 \text{ samples}$$

$$K = \left\lfloor \frac{\text{RAMSIZE}}{N} \right\rfloor = \left\lfloor \frac{32768}{162.00891} \right\rfloor = \lfloor 202.260 \rfloor = 202 \text{ periods}$$

$$L = \lfloor N \times K \rfloor = \lfloor 162.00891 \times 202 \rfloor = \lfloor 32725.8 \rfloor = 32725 \text{ samples}$$

$$f_{\text{out}} = f_{\text{clock}} \times \frac{K}{L} = 2 \text{ MHz} \times \frac{202 \text{ periods}}{32725 \text{ samples}} = 12345.30 \text{ Hz}$$

**Fig.1**

Fig.2 shows the frequency resolution which can be achieved across the full range of the generator, and also shows for comparison the original performance as given in the article. As can be seen, the error is now less than about 0.006% across the whole range. These results were generated using a C program called RES.C — which calculates the incremental resolution. I have also implemented this new method as another C program to calculate the sample set for a sinusoid, called FGEN.C. Fig.3 shows some sample output and also highlights the 'integer waveform length' problem. It is easy to see why we can't get any arbitrary frequency when we are restricted to one period.

One noteworthy point is that occasionally we will have a total waveform length of 32768 samples, exactly filling the static RAM. In these situations we do not need to attach the FFh 'end of recording' marker, as the address counter will wrap around naturally.

I trust this explanation of the improved waveform generation algorithm is of interest.

*Editor's Note: We're most grateful to Ben Low for sharing this idea and information with us all. It's one of those ideas that as soon as we saw it, our reaction*



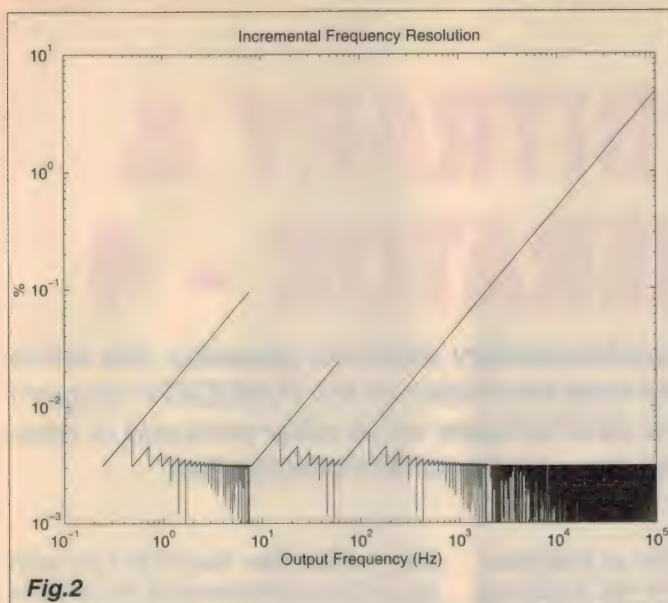


Fig.2

was "Now why didn't WE think of that?"

As far as we can see, the only possible penalty of Mr Low's technique is that the additional 'fractional sample' frequencies might have a small amount of additional sampling noise/jitter. However in practice this is likely to be negligible.

Mr Low has very kindly supplied copies of the source code for his two C

programs, which we've placed on the EA Reader Information Service BBS for any interested readers. However we resisted the temptation to incorporate his ideas into our own preliminary FUNCGEN1.EXE program (also on the BBS), to allow him to take full credit for them.

By the way it wouldn't be very difficult to use Mr Low's basic technique in

a simplified form, to provide an incremental frequency resolution of better than say 0.1% below 100kHz. You could do this simply by using 10 periods per calculated waveform 'recording' between say 800Hz and 8kHz, and 100 periods/waveform above 8kHz. Similarly you could use 10 periods/waveform between 5Hz and 16Hz, on the lowest clock range. ♦

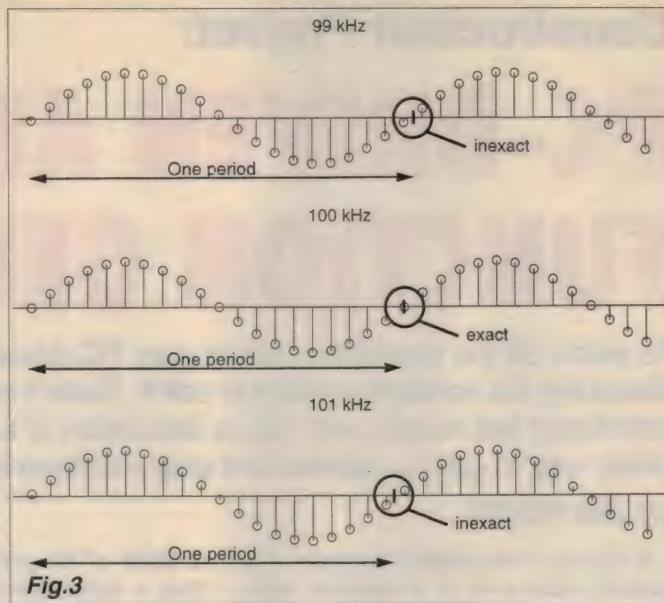


Fig.3

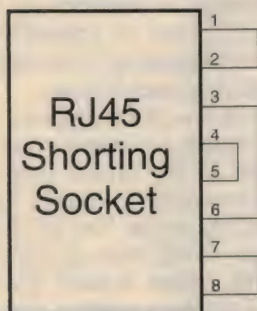
## NOTES & ERRATA

**Network cable tester** (Circuit and design ideas, February 1997): There is room for confusion in regards to the wiring of the shorting socket shown in the circuit diagram. While the pin numbers for the socket weren't shown, people unfamiliar with the pairing of cables in RJ45 plugs might be led to believe that the socket is to be wired with pins 1 and 2 shorted, pins 3 and 4 shorted, etc...

The correct wiring for the shorting socket is shown below, but note that the actual placement of the pairs is dependent on the plug's orientation — see AS 3080 for the standard connection.

(Our thanks to reader Bob Lions for pointing this out to us.)

**Turn indicator/blinker** (Circuit and Design



Ideas March 1997): The MOSFET Q1 is shown with its source and drain connections transposed - Q1 should be connected with its drain going to the positive rail.

## ELECTRONICS AUSTRALIA'S READER INFORMATION SERVICE COMPUTER BULLETIN BOARD

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- Index files for EA and ETI construction projects
- Recent notes and errata, both published and as yet unpublished
- Useful public domain and 'shareware' software for electronics and amateur radio applications.
- General interest shareware utilities, such as the commonly-used compression and decompression utilities used for efficient storage and faster file transfer.
- The ability to upload Letters to the Editor, and/or contributions to our Forum and Information Centre columns (send them as plain-text ASCII files, please)
- An on-line 'Discussion Forum' facility, which allows readers to exchange useful technical information directly.

The Electronics Australia Reader Information Service BBS is ANSI-compatible and is currently operational for virtually 24 hours each day, seven days a week, on (02) 9353 0627. Your modem can be set to any standard speed from 300 to 28,800b/s full duplex, with a data format of '8-N-1' (eight data bits, no parity and one stop bit).

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## Construction Project:

# PC-DRIVEN ARBITRARY & FUNCTION GENERATOR - 4

To round off the description of our new PC-driven function/arbitrary waveform generator, this article discusses the software needed to use it. There's some more information on the FUNCGEN1 program introduced last month, and also a discussion of some other software we've either produced or have under way, to get you started and give you more of an idea of the generator's capabilities.

by JIM ROWE

It's funny — developing this project has certainly been a bit of a marathon, with hassles and complications arising during the design and testing of both the hardware and the software. The basic idea might have seemed straightforward, but translating it into a working entity turned out to be much harder than I expected!

At the same time, and despite the hassles, it's become clear that the project was worth the effort. That's because the more we've used the prototype generators, the more we've become aware of the design's real potential. (By the way I'm using 'we' here because my colleague Graham Cattley has been closely involved with this project — especially on the software side.)

I confess that initially, even I tended

to think of the generator as little more than a replacement for the traditional function generator, taking advantage of the 'poor person's DDS' concept to generate different waveforms and using a PC for its 'user interface'. It was only as I worked on the idea a bit further that I realised it could also be used as an arbitrary waveform generator, to 'play' any kind of digitised special waveform — like those captured by our DSO Adaptor Mk2, for example, or other waveforms that one might like to 'design' from scratch, for a special testing job.

So in many ways the project's long and difficult 'birth' has been beneficial, by giving us more time and opportunity to grasp its potential.

It's also been great to get feedback

from readers, like Benjamin Low with his software enhancement to increase the generator's incremental frequency resolution at the top end. Benjamin's idea is so good that we're presenting it separately in this same issue, to make sure he gets full credit. Although we haven't incorporated his multiple-period algorithm into our own FUNCGEN1 program, at this stage, this shouldn't be too hard to do and the benefits would be quite significant.

## Standard waveforms

So let's proceed, by looking a bit more at FUNCGEN1 — the program which lets you use the generator as a fairly standard function generator. We looked at this briefly last month, but mainly in terms of using it to give your generator a quick functional test.

Fig.1 shows the program's main operating screen, which is designed to look like a 'virtual front panel'. There's a 'readout panel' in the top half of the 'panel', and underneath six control buttons which you use to operate the 'virtual function generator'. The buttons can be manipulated either by clicking on them with a mouse, or alternatively by using the <ALT> key in conjunction with the key corresponding to the letter that's highlighted on each button.

When you first fire up the program, as explained last month, you need to set it for the address of the printer port to which your generator is connected. You do this by clicking on the 'Set I/O Port Address' button, which calls up a small dialog box with option buttons giving you a choice of the three standard printer port addresses. There's also a button labelled 'TEST: Blink LED', which allows you to confirm whether you've selected the right address. Clicking on this button should cause the generator's 'LOADING' LED to flash on and off 10

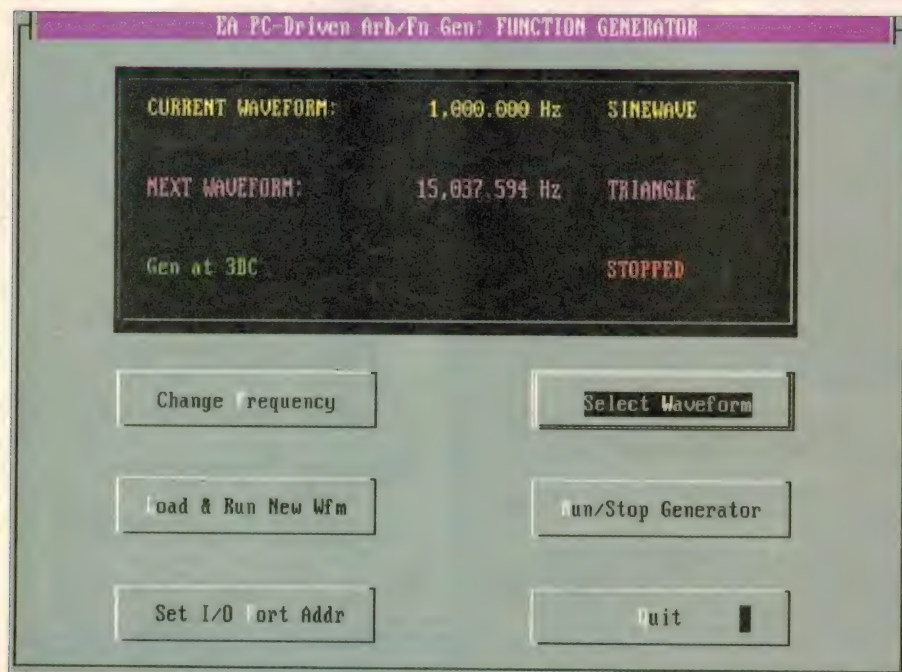
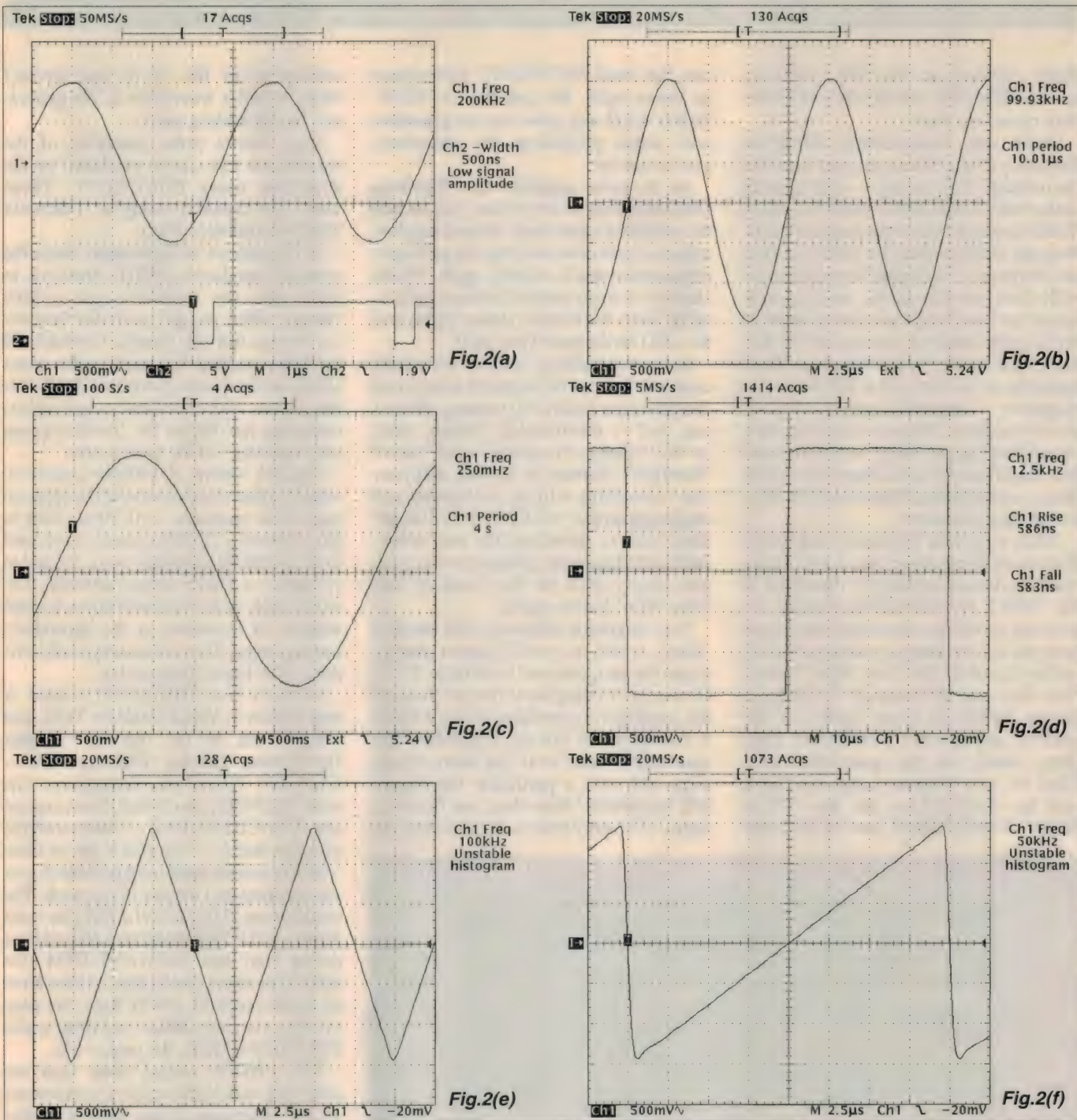


Fig.1: The main operating screen for FUNCGEN1, the function generator program, designed to present an easy to use 'virtual front panel'.





**Fig.2: Some examples of the kind of signals that can be generated using FUNCGEN1, captured using a Tektronix TDS 320 digital scope.**

times (possibly quite rapidly), so if it doesn't you can try other addresses until it does. Then you can click on the 'OK — Exit' button, to return to the main screen.

At this stage the 'CURRENT WAVEFORM' readout will be blank, as a waveform hasn't yet been downloaded into the generator. However the 'NEXT WAVEFORM' line should read '1000.000 Hz' and 'SINEWAVE', as these are the program's defaults. The word 'STOPPED' should also appear at

lower right in the readout 'window', indicating that at this stage the generator is not running.

The rest of the control buttons are almost self-explanatory, as is the readout. The 'Change Frequency' button calls up a small dialog box which allows you to type in the next frequency you want the generator to produce. When you end by clicking on the 'OK' button (or alternatively pressing the <Enter> key), the new frequency — or the clos-

est to it that the generator can produce, with its current algorithm — is displayed on the 'NEXT WAVEFORM' line of the readout.

To select the next waveform you want, you then click on the 'Select Waveform' button. This calls up another small dialog box, giving you a choice of six common waveforms: Sinewave, Square wave, Triangular wave, Sawtooth (rising), Sawtooth (falling) and Rectangular wave (Adj. duty cycle). If you select the last of



these, clicking on the 'OK' calls up another dialog box which asks you for the duty cycle you want.

By the way, whenever you change the frequency or waveform, you may note that the message 'Calculating — wait' appears in the lower centre of the readout window. This is displayed while the program calculates the sample values for that waveform and frequency. For higher frequencies and with most waveforms the message may appear so briefly that you don't notice it; on the other hand the message can be displayed for quite a while when you have asked for a sinewave at a relatively low frequency — especially on an older and slower machine. Sinewaves involve more calculation than the other waveforms, and low frequencies involve longer waveform files — so be patient if your machine takes a while to do its sums!

When your new frequency and waveform have been turned into a set of data ready to download, they're displayed in the 'NEXT WAVEFORM' readout. To load the waveform down into the generator and set it running, you simply click on the 'Load & Run New Wfm' button. You may see the message 'Loading...' appear briefly at lower centre of the readout, and also the 'LOADING' LED glow briefly on the generator itself. Then the new frequency and waveform will be displayed on the top 'CURRENT WAVEFORM' line of the read-

out, the word 'RUNNING' will appear at lower right, the generator's 'RUNNING' LED will glow and the generator will begin producing the waveform you've set up.

As its name suggests, the 'Run/Stop Generator' button simply lets you control the generator's run mode. It has a toggling action, so one click will stop the generator and another sets it running again. Which state it's in at any particular time is reflected by both the readout (lower right) and the LED on the generator itself.

A new frequency and/or waveform combination can be prepared even when the generator is already running the last one you've downloaded. Simply click on the 'Change Frequency' and 'Select Waveform' buttons as desired, and your new waveform will be calculated and displayed on the 'NEXT WAVEFORM' line. Then to download the new waveform and change the generator over to it, you simply click on the 'Load & Run New Wfm' button again.

The remaining button is that marked 'Quit', which as you'd expect simply stops the program and returns to DOS. However in doing so it doesn't modify the generator's operation; in fact it saves a configuration file to 'remember' the generator's state, so if you leave it running and with a particular waveform, it'll 'remember' this when you fire it up again. (The only time it *doesn't* save the

configuration file is if you haven't downloaded a waveform to the generator, before bailing out.)

Fig.2 shows some examples of the waveforms that can be produced by the generator using FUNCGEN1. These were all captured using a Tektronix TDS320 100MHz DSO.

In Fig.2(a) we've deliberately made the generator produce a 200kHz sinewave, to show how the waveform gets a little 'lumpy' when you get up to this frequency. As you can see, though, it would still be quite useable for many jobs. Also shown on the lower trace is the trigger output signal, with its 500ns output pulses occurring just before the 'positive-going zero crossings' of the main output.

Fig.2(b) shows a 100kHz sinewave, while (c) shows a sinewave at the opposite end of the spectrum — 0.25Hz. Then in (d) is shown a 12.5kHz square wave, and in (e) a 100kHz triangular wave. Finally in (f) there's a 50kHz rising sawtooth. The small 'kink' at the bottom is due to a small amount of overshoot in the generator's analog output filter, and is only really evident at the higher frequencies.

So that's how FUNCGEN1 is used. It was written in Visual Basic for DOS, and you'll find it on the EA Reader Information Service BBS as FUNC-GEN.ZIP. When you decompress this with PKUNZIP, you'll find it contains not only FUNCGEN1.EXE — the executable program itself — but also a set of three VBDOS source code modules which you can examine and modify if you wish. The modules are FUNCGEN1.FRM (the main form), SETPORT.FRM (the I/O address dialog box) and SETWAVE.FRM (the waveform select dialog box). These have all been saved in ASCII form for easy viewing via a text editor, and there's also FUNCGEN1.MAK, the project file.

The VBDOS source code files are provided with quite a lot of comments, so the operation of the various procedures should be fairly clear.

Before leaving FUNCGEN1, I should point out that this version is slower in operation than my original version. That's because I had to change it to use a string variable to store the waveform file in memory, instead of the original linear integer array. The array approach was more elegant and ran faster under the VBDOS interpreter, but wouldn't compile to produce an EXE file unless I reduced the array size (and hence waveform length) down to 26KB. Hence it couldn't program the generator down to its lowest possible frequency.

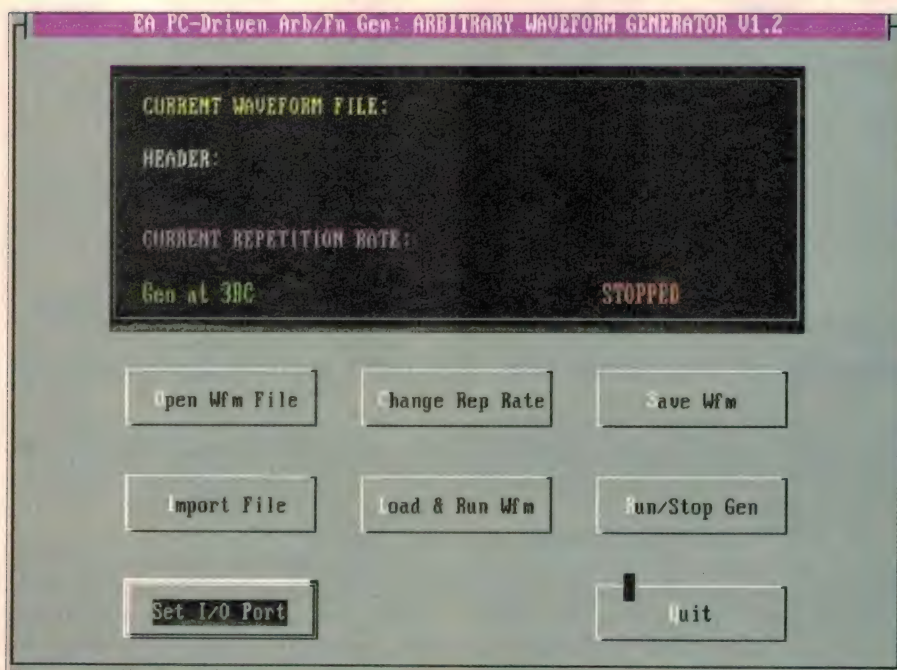
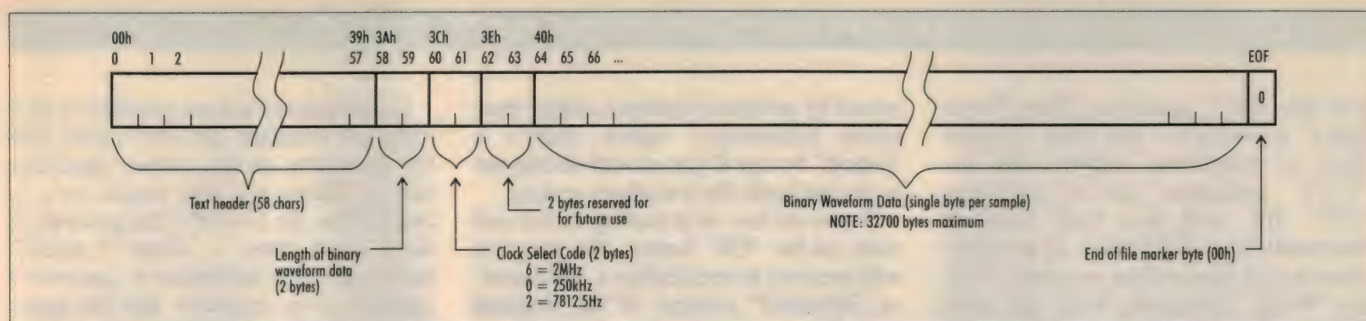


Fig.3: The main operating screen for ARBGEN1, which allows you to load, run and save waveforms, import them from other formats and vary their frequency/repetition rate.





**Fig.4: The file format used and expected by ARBGEN1 (and also by Graham Cattley's waveform drawing/editing program). The binary waveform data itself follows a 64-byte header.**

Rather than limit the frequency range, I elected to change over to the string storage approach. This at least produced a program that covers the full frequency range and *would* compile, even though it runs a little slower than I'd like. If there's enough interest in the faster version, I'll make this available on the BBS as well.

## Arbitrary waveforms

If you just want to use the generator to produce standard waveforms, the FUNCGEN1 program is fine. However it's not intended to let you exploit the generator's arbitrary waveform capabilities. For that kind of work, other software is needed.

Arbitrary waveform generators are traditionally fairly difficult beasts to 'drive', probably because their ability to generate so many different kinds of waveform tends to trip you up when you want to generate any *particular* waveform. For example it can be quite tricky to program them for a relatively simple extra 'function generator' waveform, or to design a simple variation on a such a waveform. Even converting a captured waveform from a DSO can be difficult.

Needless to say we wanted *our* generator to be as friendly as possible, so after quite a bit of thought we decided (a) to keep the arbitrary waveform programming quite separate from the straightforward 'function generator' programming performed by FUNCGEN1; and (b) to further subdivide the 'arb generator' programming itself into two further distinct parts. One of these would be devoted to manipulating arb files, loading them into the generator, saving them on disk and reloading them, converting files from other sources into waveform files and so on; the other would be dedicated to allowing you to design your own waveforms from scratch, and also editing existing waveform files — using an intuitive graphical interface.

As it happens, my colleague Graham Cattley was very interested in tackling the latter program, seeing it as a good exercise in C language programming. So he has

been working on that one, and hopes to present it shortly — probably next month. From what I've seen of it so far, it'll be well worth the wait. It looks a bit like a graphical editor for WAV sound files.

In the meantime, I've been working on the former program, called ARBGEN1. This is the one to let you manipulate arbitrary waveforms, download them into the generator and run them, save them as disk files and reload them again, and also perform conversions from other file formats.

Like FUNCGEN1, ARBGEN1 has been written in Visual Basic for DOS, and again presents a 'virtual front panel' with a readout display and various control 'buttons' (Fig.3). As before many of the control buttons call up dialog boxes to let you feed in the information the program needs.

As you can see, there's again a 'Set I/O Port' button at lower left, to let you set it up for the correct printer port. There's also a 'Quit' button at lower right, a 'Load & Run Wfm' button at lower centre and 'Run/Stop Gen' button at centre right. These all perform essentially the same functions as their counterparts in FUNCGEN1. The remaining buttons are different, though, and will now be discussed.

At upper left is a button labelled 'Open Wfm File'. Clicking on this (or using <Alt> and <O>) calls up a dialog box to let you select a waveform file from a designated disk drive and subdirectory, and load it into the program's working memory. When you do this the waveform file name is displayed on the 'CURRENT WAVEFORM FILE:' line of the display window, any text in its header field is displayed on the line below the 'HEADER:' line, and its current repetition rate (determined by the waveform length, you might recall) is displayed on the 'CURRENT REPETITION RATE:' line.

At this stage, I should perhaps digress briefly to describe the waveform file format used and expected by ARBGEN1. Rather than try to adapt any

existing file format — and risk conflicts with other software packages — we have elected to adopt a new file format specifically for the generator's waveform files. The format uses the extension 'WFM', and the basic details of the various fields are shown in Fig.4.

As you can see, it's fairly straightforward. At the start is a text 'header' field of 58 characters, allowing each file to carry its own reasonably wordy description. Then there are three two-byte parameter fields: the first giving the length of the binary waveform data, the second the generator clock code for a 'playing' the waveform at the intended frequency/repetition rate, and the third essentially a 'spare' parameter for future use.

Following these parameters, and starting at byte 64 (40 hex) is the actual waveform data, with one byte per sample and a maximum of 32,700 samples. (The actual length is given by the integer value in bytes 58 and 59, just after the header field.) Finally there's a single 'end of file' byte at the end, with a value of zero.

Getting back to the ARBGEN1 program, the 'Open Wfm File' button expects to find files of the format just described, and of course the 'WFM' extension as part of their filename. When a file is opened, its details are displayed along with '(Not Downloaded)' message — until you download it to the generator.

Similarly the 'Save Wfm' button (upper right, Fig.3) is used to *save* a waveform in the WFM format. It lets you provide the header text you want, and also nominate the disk, directory and filename.

On the other hand, the 'Import File' button is used to let you import data in various *other* file formats, and convert them into a form suitable for either downloading into the generator, or saving in WFM format. At present the program will recognise and convert files saved by Graham Cattley's PC-Driven Electrocardiogram (July 1995), with an 'ECG' extension; from Graham's Low Cost Pocket Sampler of August 1996,



with the 'PKT' extension; from David Jones' software for our DSO Adaptor Mk2 of May/June 1994, with the 'WAV' extension and a matching 'DSC' file; and also from standard Microsoft-type 'RIFF' files, as saved by many sound card editing programs, with the 'WAV' extension. With the latter files it will accept either eight-bit or 16-bit files, in either mono or stereo — but always converts them into the eight-bit format used by the generator.

Importing and conversion of these file formats is essentially automatic, if the program recognises the format. Otherwise it will display a dialog box with the message 'Sorry — file format not recognised!'. If the file format is recognised, it simply proceeds with the conversion, advising you with a 'Converting...' message. When conversion is complete, this message changes into the '(Not downloaded)' message.

The remaining button on the ARBGEN1 'front panel' is the one at upper centre, labelled 'Change Rep Rate'. As this name suggests, it's used if you want to change the effective repetition rate/frequency of the current waveform. This can be done either by changing the generator clock rate used to 'play' the waveform, or by changing the length of ('scaling') the waveform itself — or both, if you wish.

When you click on the control button, it first brings up a dialog box which gives you the option of changing the generator clock rate. The current clock rate setting is displayed, and you have the option of selecting one of the other two if you wish. The ratios between the three are displayed, to remind you of the effect of such changes. After your selection (or immediately, if you don't wish to change the clock setting) you can exit from this dialog box by clicking on either the 'OK' or 'Cancel' buttons.

You're then presented with another dialog box, offering you a further choice of either increasing or decreasing the frequency. Here you can input '1' to increase the frequency, '2' to reduce the frequency — or simply click on the 'Cancel' button to exit, if you only wanted to change the clock rate.

If you select either 1 or 2, clicking on the 'OK' button will call up a further dialog box, asking you to nominate the factor by which you want the frequency to be increased or decreased. You can only nominate whole-number factors, and the dialog box also advises the maximum factor allowable for that waveform (deter-

mined by generator memory and/or resolution limitations). Again, there's a 'Cancel' button if you should decide not to proceed with the waveform scaling.

If you do key in a scaling factor and click on the 'OK' button, the program will proceed to recalculate a 'squeezed' or 'stretched' version of the original waveform, as appropriate, and display a 'Recalculating...' message while it does so. Then at the end of the operation it will display the new repetition rate, along with the '(Not Downloaded)' message to remind you that the change won't take effect until the revised waveform and/or clock setting are downloaded into the generator.

By the way, the algorithms used to perform the waveform shrinking and expansion do perform a certain amount of 'smoothing' in the process, to avoid too much loss of resolution. However some loss of resolution is inevitable, especially with waveform expansion (frequency reduction) if you start with a waveform having a relatively high repetition rate, and use a relatively large scaling factor. The facility is not really intended for making massive changes to a waveform's frequency/repetition rate, for this reason.

## Sample files

To help you get going with ARBGEN1, I've prepared a couple of sample waveform files. One is called 2KSINE.WFM, and is simply a single period of a 2kHz sine wave. Opening this with ARBGEN1 and downloading it to the generator will produce a smooth 2kHz tone, identical with the kind of tone you can produce using FUNCGEN1. However in this case you can also use the waveform to produce many other sinewaves in the audio range, by using the 'Change Rep Rate' facilities we've just discussed. For example you can quickly use it to produce sinewaves of higher or lower frequencies, by either changing the clock rate or rescaling the waveform itself.

The other sample waveform is TWOTONE.WFM, which shows how the generator can be used to produce specialised testing waveforms. Opening TWOTONE.WFM and downloading it to the generator will produce a signal consisting of a 20ms burst of 1kHz tone (i.e., 20 periods), followed by 100ms of the same tone but 20dB lower in amplitude. In other words, a shortened (and therefore more stringent) version of the test signal used for the IHF test for amplifier 'dynamic headroom' and 'transient overload recovery time'.

Unfortunately it's not possible to generate the standard IHF test signal with the generator, as the correct repetition rate is 500ms and this would only be available at the lowest of the generator's three clock rates — where it doesn't have sufficient resolution to generate a smooth 1kHz sine wave. But the signal from TWOTONE.WFM should at least give you an idea of the generator's potential for producing 'special' test waveforms.

As with FUNCGEN1, the ARBGEN1 program will be available via our BBS — as both an ARBGEN1.EXE file ready to run, and a set of source files for your interest and possible modification. In this case the source files are ARBGEN1.FRM (the main module), SETPORT.FRM (the I/O address dialog box), SETCLOCK.FRM (the clock rate setting dialog box) and ARBGEN1.MAK (the project file). These files plus the sample waveform files 2KSINE.WFM and TWOTONE.WFM will all be zipped together as the single file ARBGEN.ZIP, for convenient downloading.

As with FUNCGEN1, ARBGEN1 is a little slower than I'd like when it's doing some of its file loading, converting and rescaling. That's because I had to change over to storing the waveform in memory as a string, rather than an integer array, before VB DOS's compiler would deign to produce an EXE file. So please, be a little patient with ARBGEN1 when it takes a little while to do some of its 'crunching' — especially on an older computer.

That's it for my two programs, which should at least get you going with the Arb & Function Generator. Shortly Graham Cattley should be able to present his nifty waveform drawing and editing program, which will complete our initial 'hat trick'.

Needless to say, the generator is one of those projects where no matter how many programs we gave you, we still wouldn't be covering everything necessary to achieve its full potential. There would probably still be situations where a different kind of program would be needed, to make it produce a *really* special test signal. But by the time you get to that stage, you'll hopefully be able to write such programs for yourself, using the information we've supplied.

Good luck with your Arbitrary and Function Generator, and if you find a really interesting application for it, why not let us know? We'll be happy to share your achievement with other readers. ♦



## Mini Construction Project:

# RS-232 UTILITY BOX

Here's how to build a flexible multi-purpose testing and adaptor box for RS-232C serial links. It combines the functions of a gender changer, a traditional breakout box, a null modem adaptor and a serial data monitor adaptor, in one compact and low cost unit. The author can also supply either complete units with matching software, or just the PCB.

by PETER SIMMONDS

Like many people who read this magazine, I have to do a lot of testing of systems which use RS-232 serial links. Now if you take a peek into the toolkits of people like myself, you will find 9 to 25-way connectors, male to male and female to female gender changers, null modems and the old standard breakout box.

Well, I was getting sick of having to put a gender changer on this cable or a null modem on that one; plus I was forever losing them. So I decided to put a few of these often-used items into the one box.

With a bit of thought I dreamed up this RS-232 Utility Box, which is easy to build and I believe would be a welcome addition to any technicians toolbox. It fits the following into one box:

- a male to male gender changer;
- a female to female gender changer;
- a null modem;
- an RS-232 serial monitor port.

This last item may require some clarification, as it goes under a few different names.

Suppose there are two pieces of equipment that are communicating with each other using an RS-232 link. You want to know if the devices are communicating, and maybe analyse what they are sending. With a breakout box using LEDs, it is sometimes difficult to see the LEDs flickering and there is no way you can analyse the data.

By plugging your PC's serial port into the serial monitor port and running the software *SeeRS232* that is included with the project, or some other communications program like Procomm or Mirror, you can view the data that is being transferred between the two units. Using two switches you can view the data going in either direction or in both directions.

The simplicity of the circuit does not make it suitable for systems that are transmitting data in both directions at the same time (full duplex). For these systems it is best if you view one direction and then the other.

The software called *SeeRS232* is a DOS program that is included with the project and has the following features:

1. Received data can be displayed in ASCII or hexadecimal format;
2. Received data can be saved to disk. It can be saved in ASCII or hexadecimal format.
3. Receiving of data can be stopped and started, allowing the user to easily view and examine data.
4. Pages of data can be displayed, with a page starting with a predefined set of characters that you have entered. For example you may wish to only start displaying data when the character string 'DS1=' is received.

## The circuit

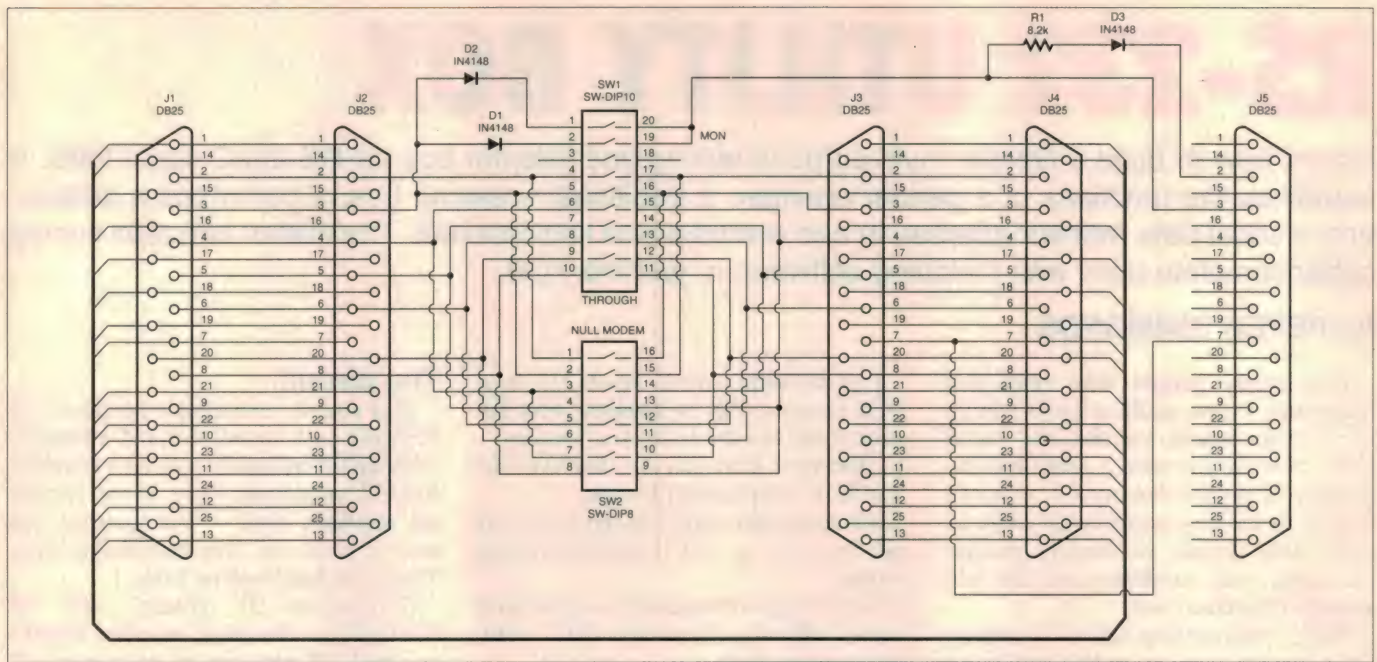
This circuit is so simple because it is basically just connectors and switches. Although there are 25 pins on a standard RS-232 connector, only seven signals are regularly used — the transmit and receive lines and five handshake lines. These are described in Table 1.

Connectors J1 (Male) and J2 (Female) are directly connected together on all 25 pins as are connectors J3 (Male) and J4 (Female). Separating the two sets of connectors are two dual-in-line switches SW1 and SW2. Switches 1 to 8 of SW1 provide a straight-through connection between the two sets for the seven signals described





# RS-232 Utility Box



**Fig. 1: The schematic for the Utility Box. Although little more than some connectors and switches, it performs the functions of a gender changer, breakout box, null modem and serial data monitor.**

above. Although switch 8 is not used, I find it easier to use if you remember there are 8 switches on SW1.

To have a gender changer, open switches 1-8 on SW2, close switches 1-8 on SW1 and then connect to J1 and J3 or to J2 and J4.

Switches 1-8 on SW2 serve to produce a null modem. A null modem allows two computers or terminals to communicate with each other by crossing over the transmit, receive and handshaking lines according to Fig. 2.

To operate as a null modem open switches 1-8 on SW1, close switches 1-8 on SW2 and then connect to J1 and J4 or to J2 and J3.

The final part of the circuit is the serial monitor. This is a fairly old trick using diodes. The transmit pin (2) on the serial monitor port will be at approximately -10V because no characters are transmitted from this port. The transmit pin (2) is connected to the receive pin (3) via diode D3 and resistor R1, which are used to ensure the receive line is at a negative voltage when no characters are being received. The other two diodes D1 and D2 are connected to pins 2 and 3 on connectors J1 and J2.

When serial data appears on these lines the signal passes through the respective diode to the receive pin on the serial monitor port. Switches SW1-9 and SW1-10 allow the user to view data on one or both lines at a time.

## Construction

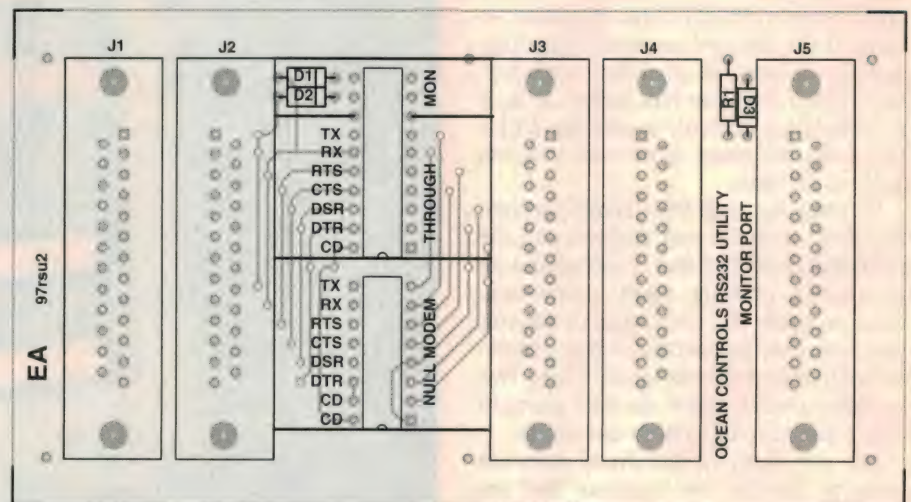
Because of this project's simplicity this will probably be the shortest construction guide you will ever see in this magazine.

First solder into place the resistor and diodes. Make sure that the orientation of the diodes is correct. Next insert and solder the dual-in-line switches, making sure they are orientated correctly. Next solder the two male DB25 connectors into positions J1 and J3 then solder the three female DB25 connectors into positions J2, J4 and J5.

The card then fits into a polystyrene

**Fig. 2: Null Modem Connections**

Computer 1	Computer 2
Tx	Rx
Rx	Tx
RTS	CTS,
CD	
CTS, CD	RTS
DSR	DTS
DTS	DSR



**The PCB overlay diagram, showing where everything goes. The DIP switches are used to select its operating mode, and connector J5 connects to a PC for serial data monitoring using the author's software.**



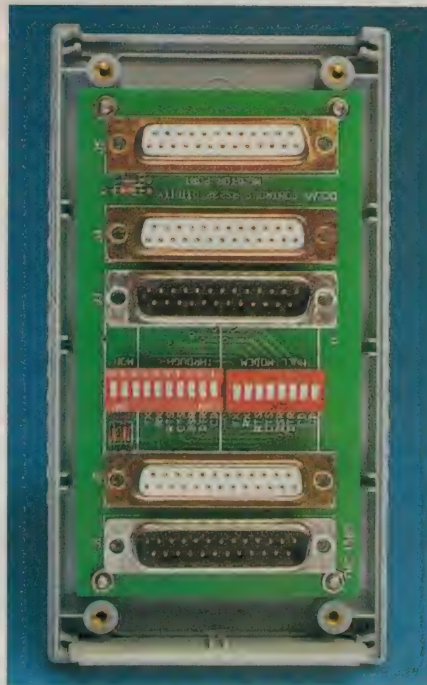
**TABLE 1:****Main RS-232C Signal Lines**

Symbol	Pin No	Description
Tx	2	Transmit data
Rx	3	Receive data
RTS	4	Request to Send
CTS	5	Clear to Send
DSR	6	Data Set Ready
CD	8	Carrier Detect
DTR	20	Data Terminal Ready

**TABLE 2:****Null Modem Pin Connections**

J1 & J2	J3 & J4
pin 2 to	pin 3
pin 3 to	pin 2
pin 4 to	pins 5 & 8
pin 5 & 8 to	pin 4
pin 6 to	pin 20
pin 20 to	pin 6

Above is a photo to give you further confirmation of where everything goes, and how the PCB mounts inside the case. Below are the top and bottom PCB patterns, reproduced actual size for those who wish to make their own board.



box measuring 150 x 80 x 30mm, available from Jaycar as part No.HB-6034. A rectangular cutout has to be made in the box to allow access to the switches and connectors. The card sits on four 12.5mm nylon PCB spacers.

First drill out the internal supports in the box to fit a 3mm screw. Place the spacers on the four internal supports and use four 25x3mm bolts and nuts to attach the PCB to the bottom half of the box.

Finally screw on the lid of the box, and it's finished.

**Testing**

If you haven't got much equipment, the easiest way to test the unit is to use a DMM and switch it to Ohms. Measure to see if there is a short circuit between connectors J1,J2,J3 and J4 on pins 1, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24 and 25.

Next open switches SW2 1 to 8 and close switches SW1 1 to 8. Test for a short circuit between connectors J1, J2, J3 and J4 on pins 2, 3, 4, 5, 6, 8 and 20.

To test the Null Modem mode, open Switches SW1 1 to 8 and close switches SW2 1 to 8. With the DMM check that there is a short circuit between the pins listed in Table 2.

Leave the switches in the null modem position. To test the serial monitor you will need two PCs. Plug one of the PCs into connector J1 or J2 with a straight-through cable. Plug the other PC into the serial monitor port. Run the program *SeeRS232* on both PC's in DOS. Make sure the settings are the same on both — e.g., 9600b/s, no parity, 1 stop bit and ASCII format.

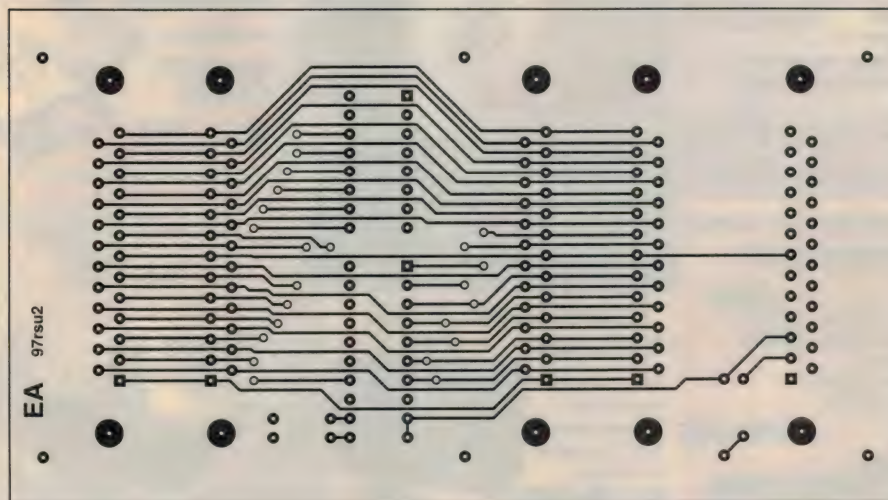
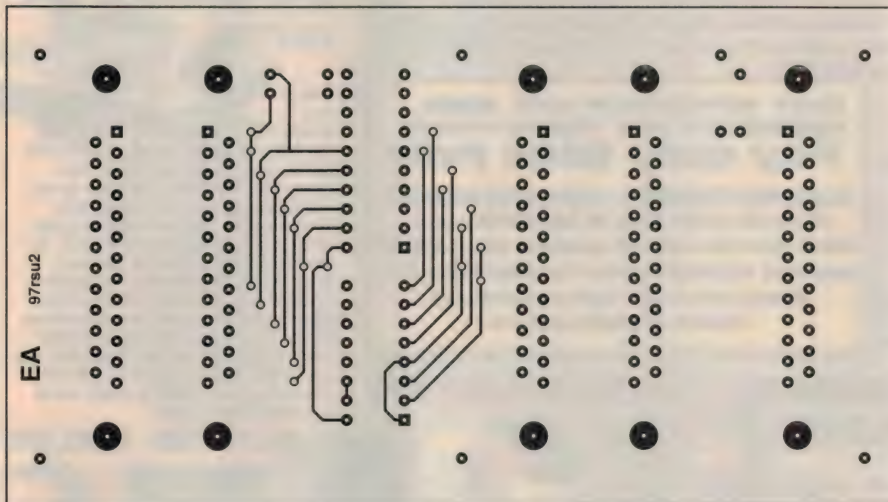
Press the G key to Go. Pressing the Home key returns you to the settings screen. Pressing the F1 key brings up the help screen. A full explanation of the program is found in the Readme.doc file.

Start typing on the PC connected to J1 or J2. If Switch SW1-10 is closed, characters will appear on the screen of the second PC. Now connect the first PC to connector J3 or J4 and start typing. Characters will appear on the second PC's screen when switch SW1-9 is closed.

**Conclusion**

This versatile RS-232 utility box will enable you to connect systems using RS-232 links much more easily, plus also allow you to analyse what's going on between them.

The RS-232 Utility Box is available as a complete unit, including the software, for \$60 from Ocean Controls, of 4 Ferguson Drive, Balmarring 3926; phone (059) 83 1163. The PCB and box are available for \$20. Postage and handling is \$8. ♦

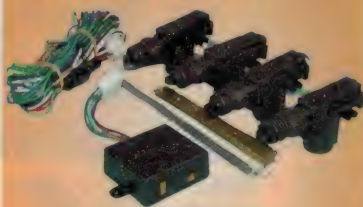








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This cabinet measures  
540(W) x 290(D) x  
290(H)mm when built



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-3dB Frequency 39Hz  
Port Length 165mm for 66mm dia

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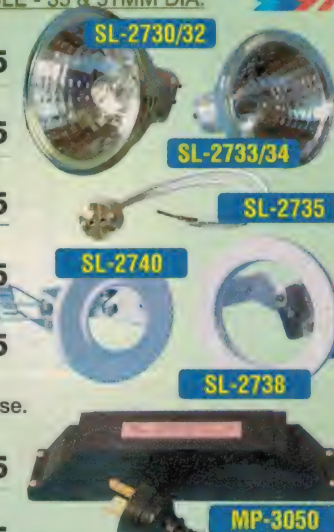
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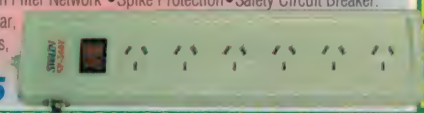


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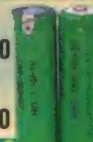
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Ref: Electronics Aust Dec '96, Feb, March, April 1997

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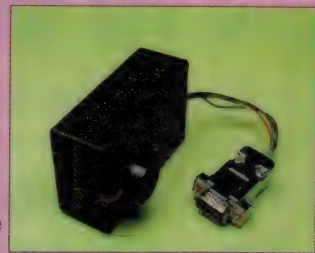
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## AUDIBLE ALARM KIT FOR CRITICAL CAR SYSTEM

Ref: Electronics Australia March, 1997.

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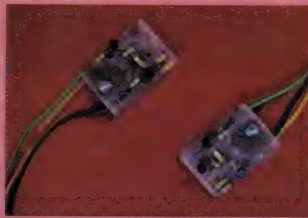
Cat. KA-1791

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Ref: Electronics Australia April 1997.

Fit this tiny kit to your car and the courtesy light will stay on for an extended period of around 10 seconds after the door is closed, then fade out gradually. A headlight interlock feature cancels the delay extension when the car lights are switched on. It can be installed without cutting any existing wires and can be configured to suit virtually any vehicle. The PCB measures just 31 x 41mm so the entire assembly will fit a 35mm film canister (not supplied). Kit includes PCB and specified electronic components.



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Ref: Silicon Chip March, 1997.

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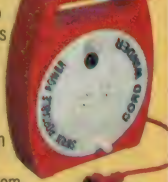
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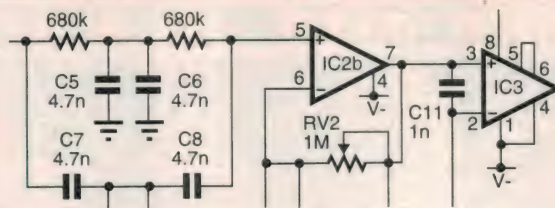
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# \$10 Wonders

by OWEN BISHOP



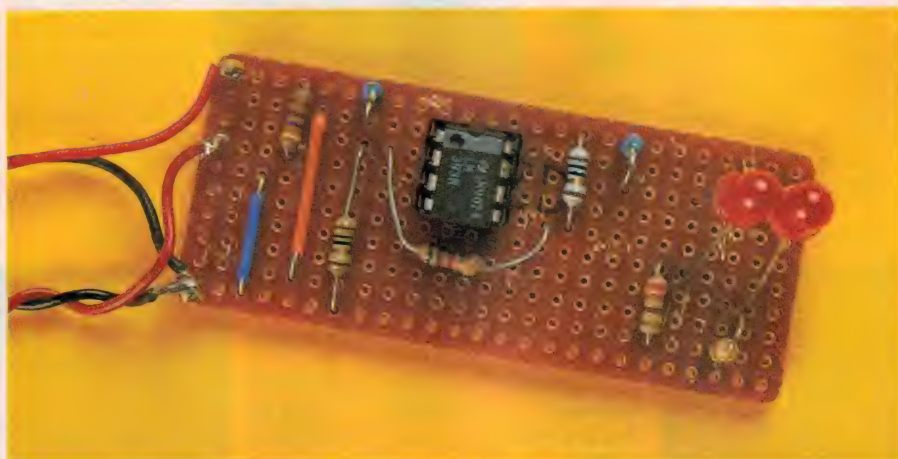
## 1: Continuity tester

Here's the first in a series of simple low-cost circuits that can be built for under \$10 — or even cheaper if you use parts gleaned from old discarded projects. With the emphasis on giving you value for money, this series will give you the chance to build some useful little circuits using some of that small change in your pocket.

In this series of projects, we reckon on an average of \$1.60 toward the cost of the board, terminal pins and wire, plus the cost of parts (many of which can be scrounged from past projects or a well stocked junk box). To keep the price down I'm afraid that no ready-made PCBs are allowed! All the designs are built on pieces of stripboard, and the cheapest way to get this is to buy one large board and cut it into smaller pieces as required, using a fine-toothed hacksaw. File the edges smooth and slightly round the corners.

One of the advantages of using stripboard in this series is that the circuits are simple and you may want to modify or adapt them to suit your own designs. Stripboard allows you to do this in a way that ready-made PCBs do not.

The ten dollar limit does not include the cost of an enclosure, as most of the circuits are battery-powered and can be left open. You can look for a suitably-sized plastic box in the garage, kitchen or bathroom, but if you are really proud of your workmanship and insist on housing it accordingly, there are a number of small ABS plastic project boxes ('Jiffy boxes') available, costing an additional \$4 - \$8.



### The circuit

This first circuit is essentially a meter that indicates whether the resistance across the input probes falls into one of three ranges: less than  $0.5\Omega$ , higher than  $0.5\Omega$  but less than  $3k\Omega$ , or greater than  $3k\Omega$ . The circuit is based on two comparators contained in a single LM393 IC, which is intended to run on a single supply. Here we use 9V for the convenience of being able to employ the compact PP3 battery as the power source.

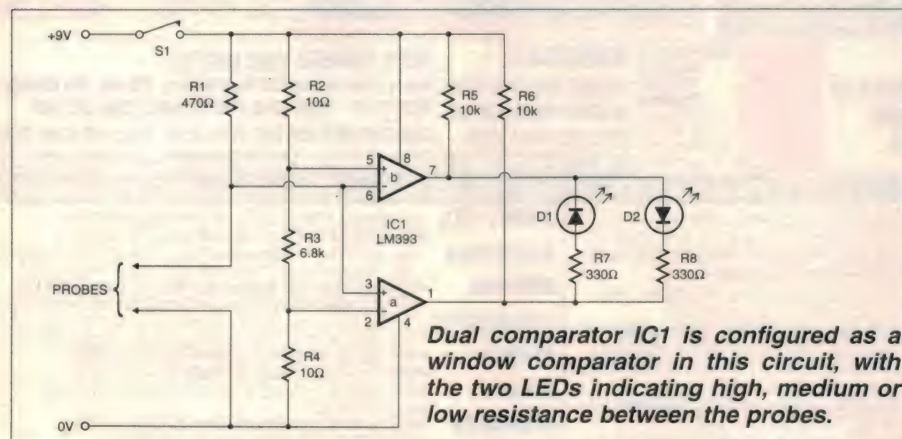
The output of the comparator swings

positive (almost to 9V) when the voltage at its positive input is higher than the voltage at its negative input. If the negative input is positive with respect to the positive input, the output swings low (almost to 0V). The LM393 has open-collector outputs, which is the reason for the two  $10k\Omega$  pull-up resistors, R5 and R6.

One input to each comparator comes from the junction between R1 and the positive probe, the other probe being connected to the 0V rail. With a short circuit (SC) or low resistance (something less than half an ohm) between the probes, the voltage at this junction is very close to 0V.

When there is a high resistance or open circuit (OC) between the probes, the junction is pulled close to 9V by R1. With intermediate resistances, the junction voltage is somewhere between 0.01V and 8.99V.

The other input to each comparator comes from the potential-divider chain R2/R3/R4. Calculation shows that the voltage at junction R2/R3 is 8.99V and at R3/R4 it's 0.01V. The comparators are connected so that they differentiate between three test conditions as shown in Table 1.





With the resistor values used in this project, a short circuit is equivalent to a resistance less than about  $0.5\Omega$  and an open circuit is equivalent to a resistance of about  $3k\Omega$  or more. Testing for short circuits is useful for checking continuity, to establish that soldered joints are good, that tracks are unbroken or that there are no unwanted bridges between tracks, and that the resistance of the dielectric of capacitors is sufficiently high. Open circuit testing is useful for checking transistor and diode junctions. This device also indicates when a resistance is in the  $0.5\Omega$  to  $3k\Omega$  range, which is useful for monitoring resistances in certain circuits.

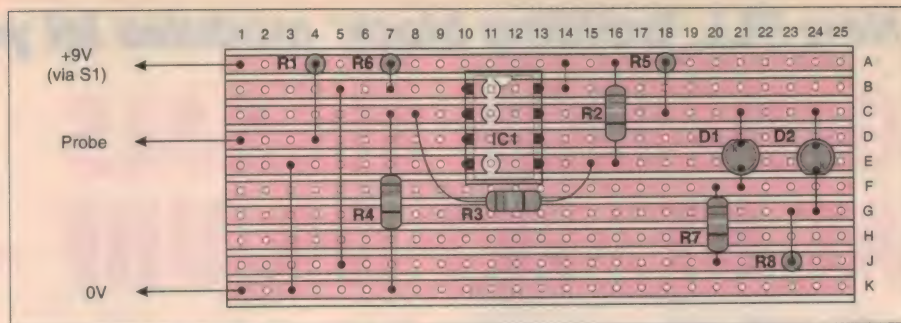
## Construction

We are using IC sockets in this series, in spite of the extra cost. This is because a socket makes it so much easier to remove the IC for testing a faulty circuit, as well as allowing you to use it in a future project.

Begin construction by cutting the strips at B11, C11 and E11. Note that there is no cut at D11 because we are making use of the D strip to connect pin 3 to pin 6. No other cuts are needed. Solder 1mm terminal pins at A1, D1 and K1. Points A13 and B13 can be connected either by the wire link as shown, or by a blob of solder beneath the board.

The circuit may be assembled completely before testing it, but remember that the two LEDs are mounted with opposite polarity, as indicated by the 'flat' on their rims. If you prefer, the LEDs may be mounted off-board, using flexible wires to connect their terminals to the appropriate holes on the board.

For probes, we used a pair of crocodile clips on flexible wires about 150mm long. Or the positive probe could be a piece of stout wire (from a large paperclip, for example), projecting from the board or case, while the negative probe lead could end in a clip for connecting to the 0V rail of the test circuit. As the entire project fits neatly on a small piece of stripboard, it can easily be mounted in a typical hand-held 'instrument case'. If you elect to mount the tester in a case, the board can be secured using a lump of Blotack.



The switch S1 is optional with an unenclosed circuit. Although a pushbutton has the advantage that the current is automatically turned off when the tester is not in use, a switch leaves both hands free for manipulating the probes. Make your choice!

## PARTS LIST

### Resistors

All 0.25W 1% metal film:

R1 470 ohms

R2, R4 10 ohms

R3 6.8k

R5, R6 10k

R7, R8 330 ohms

### Semiconductors

D1, D2 Light-emitting diodes (any shape and colour)

IC1 LM393 dual comparator

### Miscellaneous

S1 Pushbutton or switch . . . . . (optional)

Stripboard, 10 strips x 25 holes; 3 x 1mm terminal pins; 8-pin DIL socket for IC1; 2 x crocodile clips or other parts for probes; 9V battery and snap.

## Testing, testing...

Testing the finished continuity tester is simple. When power is applied, and assuming that the probes are unconnected so that we have open-circuit conditions, you should find that D1 comes on, and D2 is off. Touch the probes together (short-circuit), and with any luck, D1 will go out and D2 will turn on instead. With the probes joined by a resistor in the range of  $1\Omega$  to about  $3k\Omega$ , both LEDs should be off.

If the circuit does not behave as expected, make the usual visual inspection (use a magnifier) for uncut tracks and solder bridges between tracks. Also check carefully for dry

joints, as these can be hard to spot. Confirm that the LEDs are mounted correctly (opposite ways round). With the circuit switched on, the comparator outputs should be about 8.9V when 'high' and 0.01V when 'low', but only in the intermediate condition, with both lamps out. In OC or SC conditions a 'high' output is only about 2.1V, due to the current being drawn by the illuminated LED.

## Other applications

The values of R2, R3 and R4 may be altered to obtain different resistance ranges. Decide on the two break-points RA and RB between the three ranges. R1 may be  $470\Omega$  as before, but could be considerably higher. A higher value means a smaller and therefore safer current flows through the test circuit. The reason R1 is so low in the continuity tester is that we need a reasonable current to produce a significant voltage drop across a near short-circuit ( $0.5\Omega$ ).

Calculate the voltages VA and VB at the positive probe for your two break-points. Then:

$$R4 = VA(R2 + R3)/(VS - VA),$$

and

$$R2 = (VS - VB)(R3 + R4)/VB$$

where VS is the supply voltage (9V). These equations give only a starting point, because voltages in the chain depend on the current drawn by the comparator inputs. Also, the current flowing into a comparator changes as its output swings from low to high. So you will probably need to experiment on a breadboard to get exactly the right values, especially if your break-point voltages are very close to supply voltages, as in the continuity tester.

Another variation is to permanently wire a thermistor in place of the probe. Now we have a three-range thermometer, indicating 'too cold', 'acceptable' and 'too high'. Usually it is best if R1 is made equal to the  $25^\circ\text{C}$  resistance of the thermistor.

If you wire a light-dependent resistor in place of the probe, the project becomes a three-range light meter, with many other applications. ♦

**TABLE 1: Conditions & Indications**

Condition	Comparator A	Comparator B	Result
Short circuit	(+) lower than (-) Output swings low	(+) higher than (-) Output swings high	D2 lights
Intermediate	(+) higher than (-) Output swings high	(+) higher than (-) Output swings high	Both LEDs out
Open circuit	(+) higher than (-) Output swings high	(+) lower than (-) Output swings low	D1 lights



New PLL 'building block' modules let you

# GENERATE SIGNALS AT HF, VHF OR UHF - 3

In this third article in his short series describing two new phase-locked loop modules for VHF and UHF, the author discusses using the VHF module to extend the frequency range of our PC-Driven RF Sweeper, which used his YADDS-1 synthesiser module and wideband RF log detector module.

by TIBOR BECE

The photo of Fig.10, like that shown on page 67 of the February article, shows the inside of a YADDS RF Sweeper extended with an additional VHF PLL module. The circuit diagram of this unit is shown in Fig.11. As you can see, the output of the YADDS-1 synthesiser module is either fed directly to the generator output as before, or used as a reference for the YAPLL-V PLL module. In the latter case, the instrument's RF output signal is

obtained from the YAPLL-V module. If a YAPLL-V module fitted with a POS-150 VCO is used, this configuration extends the frequency coverage of the basic unit into the 65MHz - 150MHz band.

The mechanical layout shown in the picture is a result of more than one year of experience with various RF sweeper units, and can be recommended for just the basic RF Sweeper as well. It provides the best isolation between the gen-

erator and detector section, thus maximising the useful dynamic range.

As previously, the chassis is built up from a blank PCB laminate, but this time the ground plane is soldered directly to the copper of the front panel to form a solid, case-like structure. The dividing wall between the generator and detector sections is also soldered in to add mechanical rigidity, and in this case, it holds the VHF PLL module as well.

Space is at a premium if the original

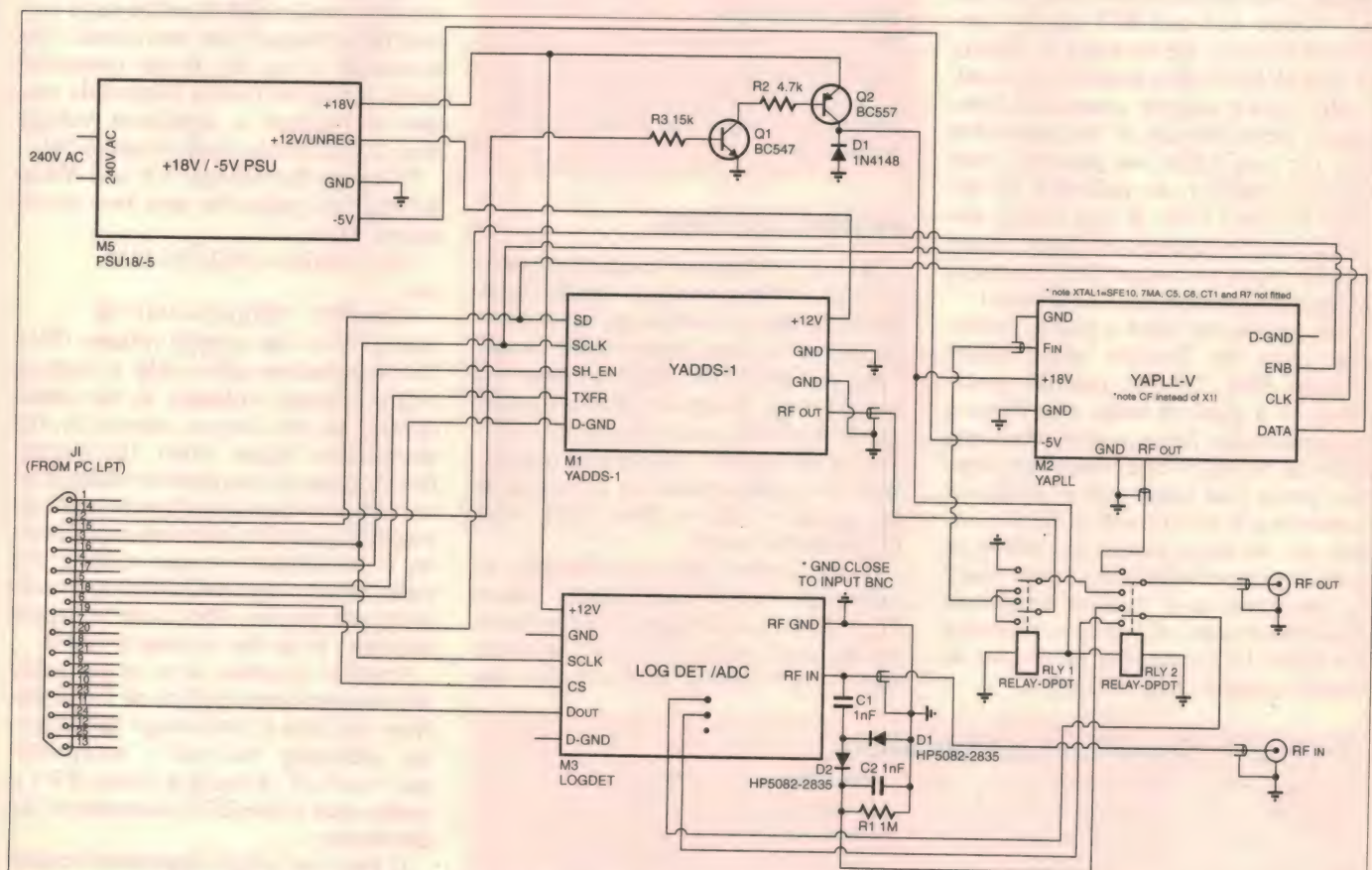
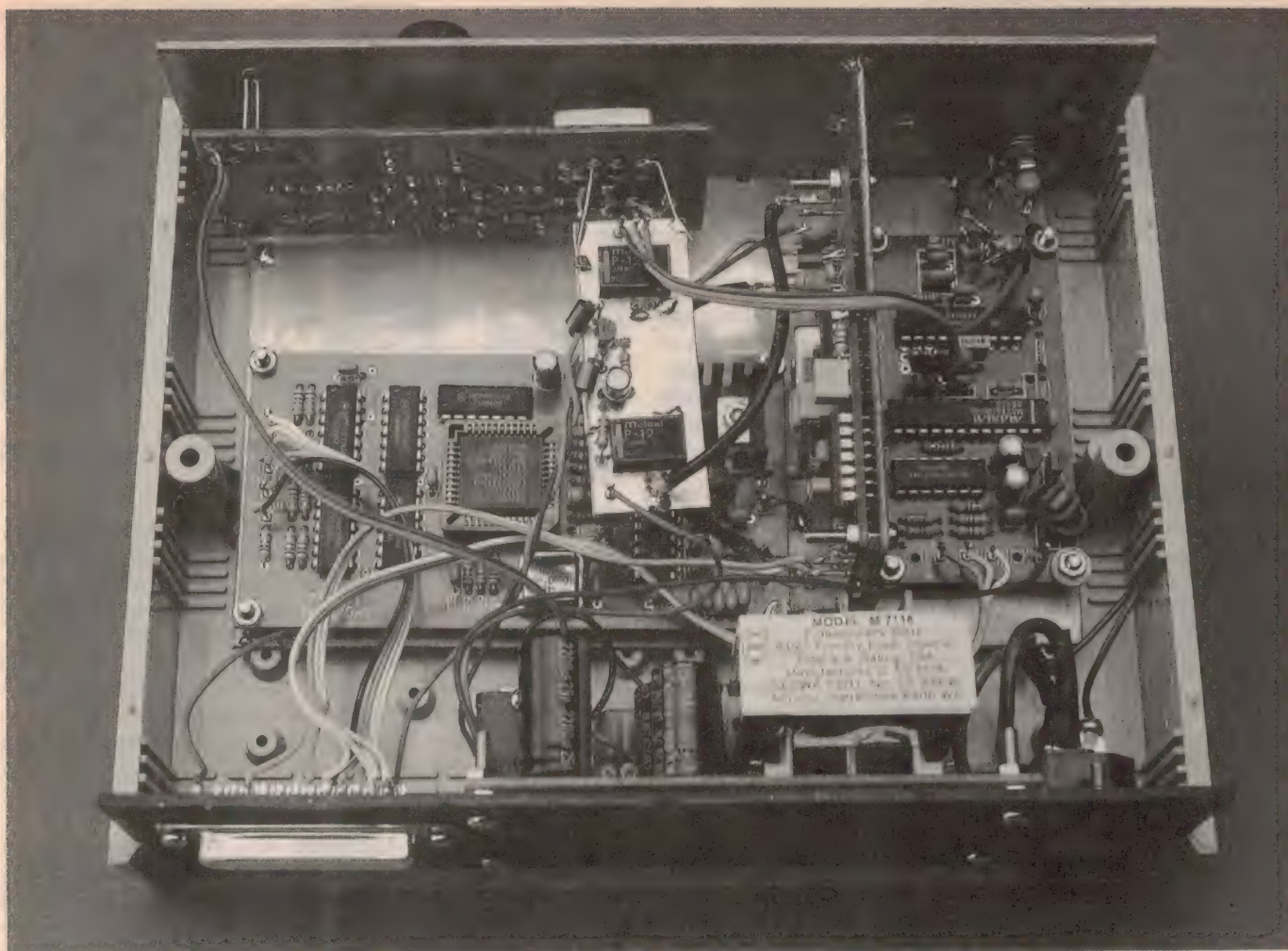


Fig.11: The circuit diagram for the YADDS RF Sweeper when enhanced using the YAPLL-V module. The relays used to switch signal paths in VHF modes, and their driver transistors, are mounted on a small PCB module.





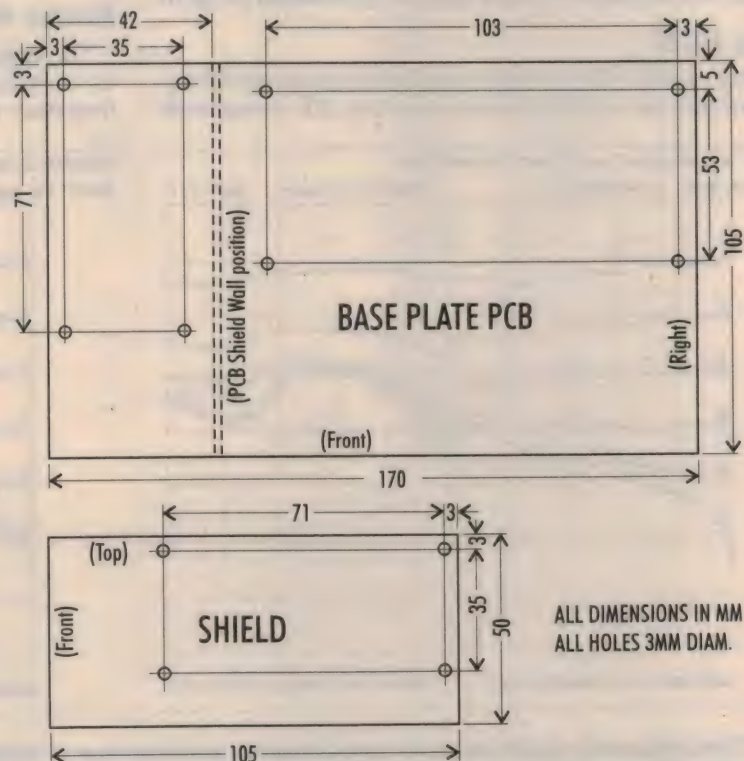
**Fig.10 (above):** Another picture inside the YADDS sweeper with the VHF PLL module fitted, showing the layout.

**Fig.12 (right):** The cutting and drilling information for the PCB laminate 'chassis plate' and shield.

size instrument box is used. Thus to simplify construction, Fig.12 shows the exact dimensions and hole positions for the required ground plane and divider wall — both made from unetched PCB laminate.

Note that the PLL module is mounted on the divider wall without the usual spacers; only an additional M3 nut is used on each mounting bolt. Note also the short pieces of wire connecting the YADDS-1 and LogDet ground terminals to the PCB chassis/groundplane, and note that the LogDet board digital ground is not connected at all — not even to the DB25 connector!

A modified version of the 95SWA9 output attenuator board is used on the output. The PCB is made narrower so that the attenuator can be fitted without clashing with the new arrangement of the chassis. Also the attenuator PCB itself is built on double-sided material,





with the top layer left as a solid ground plane. As usual for this style of RF assembly, all component leads connected to ground are now soldered from the top side of the PCB as well, whereas the unconnected leads are kept clear from the ground plane by removing the copper with a 3-4mm drill point.

The PCB wiring and overlay pattern for the modified attenuator board is shown in Fig.13.

For comparison, the frequency response of the original and modified attenuator boards are shown in Fig.14, side by side. As you can see, with this modification the original design of the attenuator PCB serves well even in this extended frequency range in the 0dB to -30dB positions. If more than 30dB attenuation is required, an external BNC attenuator will have to be used (available from RS and Farnell, for example).

## New power supply

A new power supply board is required to provide a stable +18V and -5V for the PLL module, in addition to the +12V required for the YADDS-1. The circuit diagram for the new power supply is shown in Fig.15. As with the previous 95DPS12 supply, a PCB mount transformer is used.

An LM317 regulator, set for an output voltage of 18 volts, supplies the YAPLL-V and the LogDet module. The unregulated input to the LM317 is provided by an unusual full-wave voltage doubler arrangement — providing all the benefits of a full wave rectifier circuit (half the ripple voltage, double the ripple frequency, less thermal stress on the transformer windings due to pulse currents) in a voltage doubler configuration.

The negative 5V line is supplied by a standard three-terminal 7905 regulator. The PCB is laid out for a TO-220 device in this position, but in light of the very low current consumption from the -5V line, a 79L05 low power version can be used here. However observe the different pinouts of the 7905 and 79L05: pin 1 of the 79L05 goes where pin 3 of the 7905 used to be. The wiring overlay for the new power supply PCB is shown in Fig.16.

## Relay PCB

A relay switch PCB is used to provide the necessary RF signal switching and routing between the basic RF sweep mode

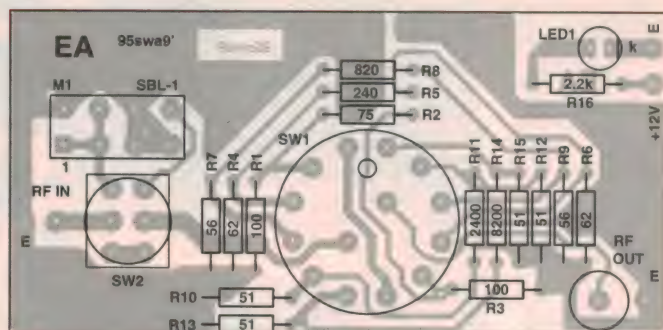


Fig.13: The PCB overlay/wiring diagram for the modified attenuator and external doubler PCB.

and the extended VHF sweep mode. Two relays are necessary in this case to prevent the 10.7MHz YADDS-1 output, used as a reference to the PLL module, from leaking through to the output BNC socket in the VHF sweep mode. As an additional benefit of using two relays, one spare contact set is available, which is used here to toggle the ADC input between the MC3356 log detector output in the RF sweep mode, and a diode detector section in the VHF sweep mode.

The small relays that were used here are available from Altronics Distributors (Part No. S-4130). They have very small parasitic capacitance between contacts and are well suited to switch RF signals up to 500MHz.

Fig.17 shows the layout for the relay PCB, which is again a double-sided board with the top copper layer used for a ground plane. It is important to keep the ground leads for the coaxial cables as short as possible, thus some of the coaxial cables are soldered directly to the bottom side of the PCB — refer to Fig.10 for details.

## Better detectors

The original log detector circuit, using the MC3356 IC, is usable only up to about 70MHz. To complement the extended frequency range of the generator section, a wider frequency

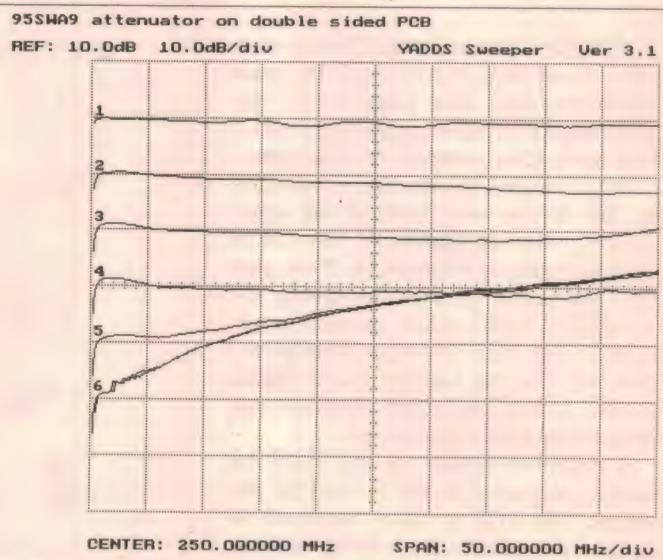
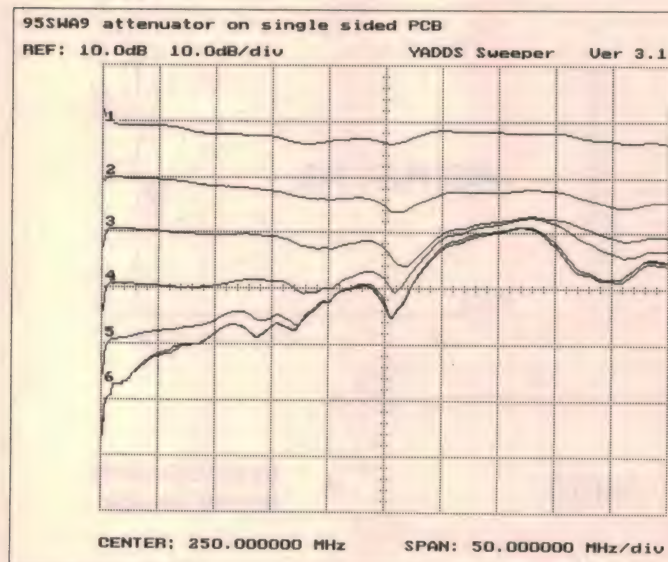


Fig.14: Two frequency response plots comparing the performance of 95SWA9, the original attenuator PCB, with the modified version. The left plots (a) show the original, the right plots (b) the new board on a double-sided PCB with ground plane.



range detector is required.

The simplest detector, as used in this example, is made up of two low-barrier Schottky diodes, HP5082-2835 in this example. With this detector, the 12-bit A/D converter is used to its fullest — useful readings are obtained for detected DC voltages as low as 1mV (corresponding to an RF input level of around -30dBm).

An additional benefit of the diode detector is that it is essentially frequency independent. Thus it can be used if an external SBL-1 frequency doubler is used to extend the frequency range of the VHF PLL up to 320MHz. The NEC 1SS99 diodes can also be used with the same success, but the more popular HP5082-2800 will provide a few dB less dynamic range.

As an alternative to the diode detector, the LogDet board can also be 'pushed to the limit' by replacing the MC3356 chip with a MC13055. For applications up to 100MHz this provides more dynamic range than the diode detector. The MC13055 is a new generation RF device, functionally compatible to the MC3356 with twice the usable frequency range.

The circuit of a detector stage based on the MC13055 is shown in Fig.18(a). The MC13055 can be fitted to the LogDet board without any changes, by aligning pin 8 of the MC13055 with pin 10 of the MC3356. If you're upgrading an existing LogDet board, the simplest method is to cut the pins of the old MC3356 as close to the package as possible, and then remove the IC pins one by one with a hot soldering iron.

The MC13055 will increase the available dynamic range of the basic LogDetector starting from 40MHz, and will provide up to 20dB improvement. It is usable (with concessions) up to

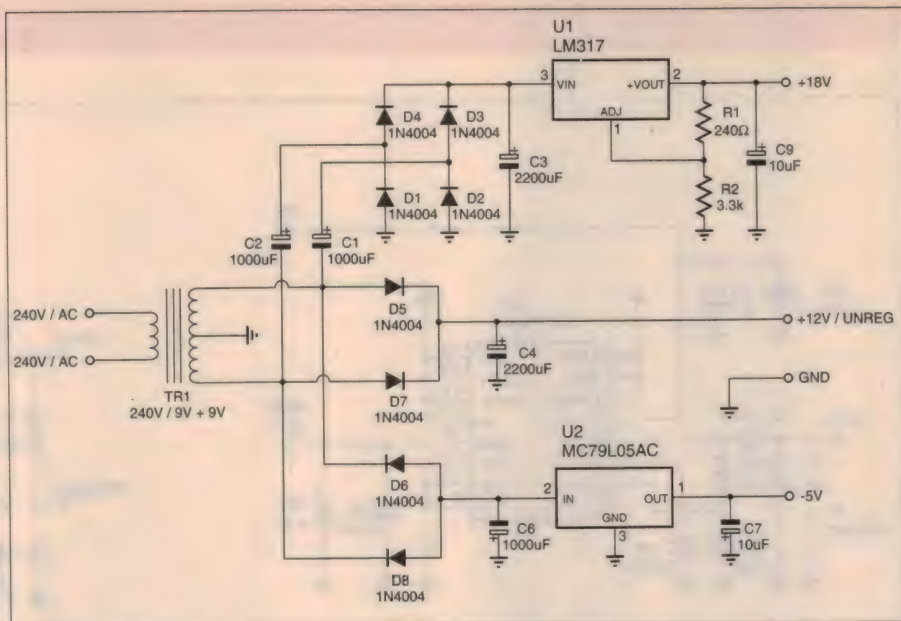


Fig.15: The circuit for the combined 18V/12V/-5V power supply module needed for the enhanced RF Sweeper.

150MHz. The calibration file for the MC13055 (covering the frequency range from 1MHz to 150MHz), is included with the YADDS Sweeper distribution software starting from V3.20.

If price is of no concern, an excellent solution is to use an Analog Devices AD606 logarithmic detector IC. This IC will provide around 70dB dynamic range at 145MHz — far superior to either the diode detector or the MC13055. The circuit diagram of a suitable 'front end' log detector using the AD606 is shown in Fig.18(b).

There is an evaluation board available for this IC as well, and perhaps the easiest way to fit the improved front end to the Sweeper is to use one of these ready-made boards. To obtain the 70dB dynamic range at 150MHz, the ground

plane of the AD606 PCB has to be soldered directly to the front chassis near the input BNC and the positive supply lead decoupled using a ferrite choke.

Note that the exceptional quality of the AD606 is not for the faint hearted or budget-limited — the AD606 is not cheap. But as usual, 'you get what you pay for'...

Fig.19 shows the available minimum indication for the four various detector sections. Clearly, the AD606 (trace 3) is

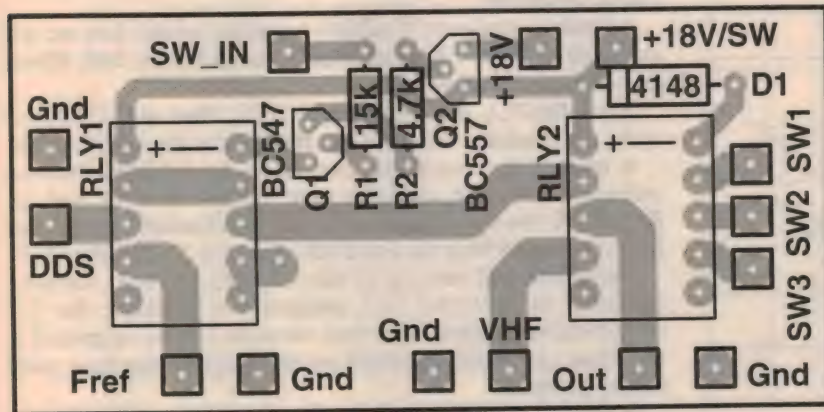
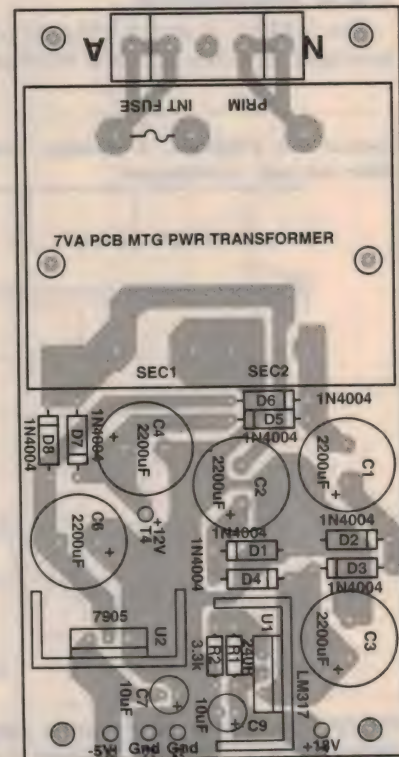
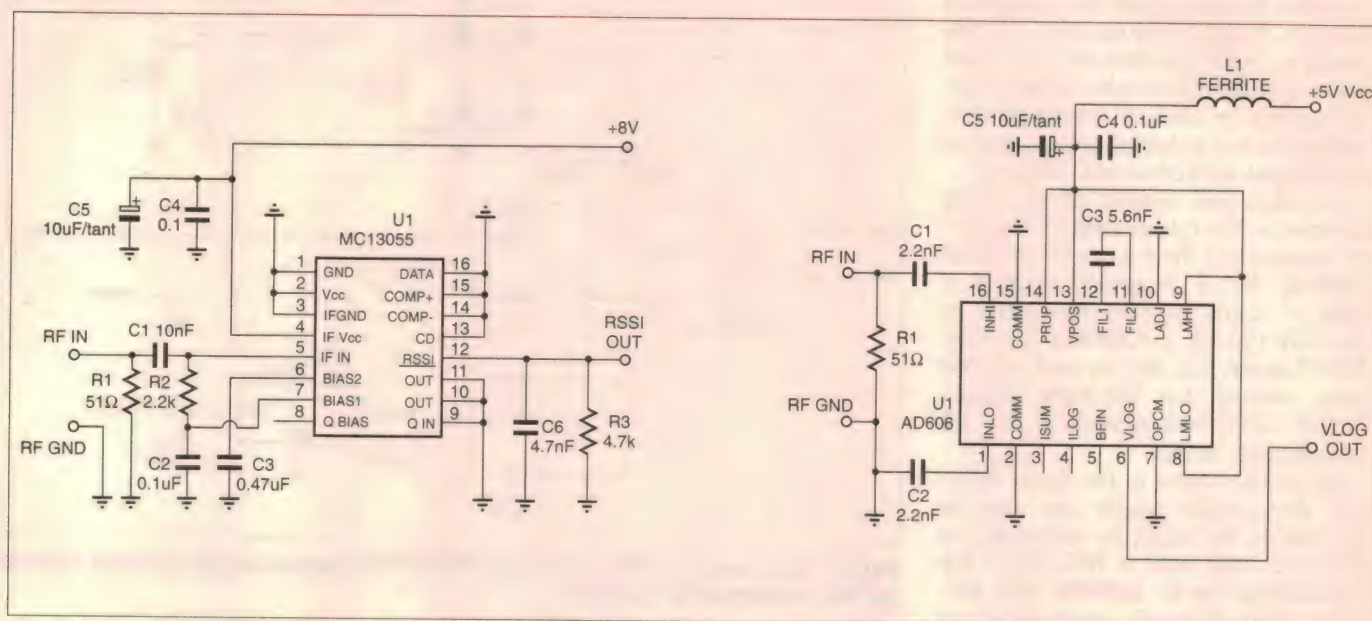


Fig.16 (above): The overlay/wiring diagram for the small relay PCB.

Fig.17 (right): The overlay/wiring diagram for the new power supply board. Like the 95DPS12 supply, it uses a PCB-mount transformer.







**Fig.18: Circuit details of the two alternative wideband logarithmic detector stages. (a) at left uses the MC13055, (b) at right uses the AD606.**

far superior to the others. Up to 70MHz the MC3356 is adequate (trace 1); up to 100MHz the MC13055 may be more suitable than the diode detector (trace 2). When considering the diode detector range (trace 4), keep in mind also that the MC3356/MC13055 start clipping at around -10dBm input; the AD606 is usable up to +13dBm at low frequencies (0dB at 150MHz), while the diode detector handles +17dBm easily. Thus, an external wideband 20dB gain block can be very handy if a diode detector is used.

## Parts availability

The YAPLL-V and YAPLL-U printed circuit boards are available from the author at PO Box 1379, Sunnybank Hills

4109, for \$25 each. The MC145170P and MC145191F ICs are available for \$18 each. A limited number of VHF and UHF PLL kits are also available, for \$69 and \$79 respectively plus \$5 packing and postage. The PLL kits do not include the Mini-Circuits VCO modules, and are supplied with the parts configured for an external DDS frequency reference (10.7MHz ceramic filter, loop filter components set for 100kHz reference).

The MiniCircuits VCO modules, directional couplers, and amplifiers are available from Clarke & Severn Electronics, of Unit 4, 8A Kookaburra Road, Hornsby Heights 2077. For availability of the Motorola MC13055 log detector IC, contact the Motorola distributors in Australia; Veltek or VSI Avnet.

The Analog Devices AD606 or its evaluation board, the AD606EB is available from HarTech, the Australian distributor for AD. A limited number of AD606EB evaluation boards are available from the author for \$99 + \$5 P&P in single quantities.

A limited number of YADDS-1 synthesiser full kits are still available for \$109. LogDet kits are available for \$69. Please add \$5 P&P for all orders.

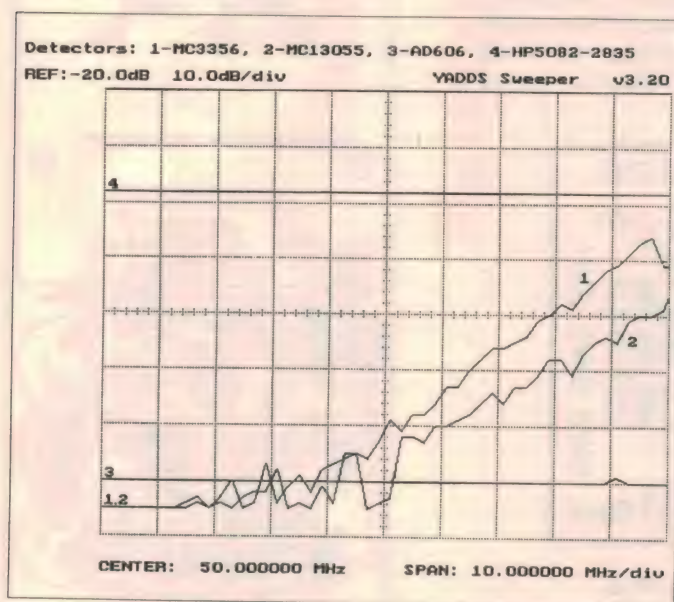
The DDS/PLL drivers, as both 'EXE' files and 'C' source code, are available from the EA BBS in the file YAPLL.ZIP.

A limited, baseband-only version of the YADDS Sweeper software, complete with the new calibration files and the README file that applies to the latest unlimited version, can be downloaded from the EA BBS in the file 'DDSWP10.ZIP'.

The latest, full version of the YADDS Sweeper software (required to drive the PLL modules) is available for \$49 only from the author. Previous versions can be upgraded to the latest one with full credit on the original purchase price of the software.

In the last of these articles, I'll discuss the software side in more detail. I'll also explain how to extend the enhanced Sweeper into the UHF range, and give some examples of its many applications.

(To be continued.) ♦



**Fig.19: The available dynamic range using various log detector stages. Reference level is at the top.**



## Practical workshop techniques:

# BUILDING SUCCESSFUL 'RAT'S NESTS' - 2

Here is the second article in the author's series designed to provide newcomers with the background and construction techniques necessary to make quick but successful 'lashups' of all types of electronic circuits. This time he discusses power supply and safety considerations, and also gives a sample project which illustrates some of the principles discussed to date: a simple wideband video amplifier.

by ANDREW PIERSON

Most 'lash ups' will be powered (at least initially) from a separate bench power supply. Because of the exposed nature of the circuit and the fact that it is being continually worked upon, the power supply used should have effective current limiting facilities.

Common causes of accidental supply rail shorts are: attacking the rail with an earthed soldering iron; bridging the rail to earth with a meter probe; and inadvertent polarity reversal of tantalum 'tag' capacitors when used as rail bypasses. In the latter case, a current limited power supply may well prevent such devices from turning into 'mini hand grenades'!

### High voltage safety

Fortunately, most modern circuitry uses safe operating voltages, but there are some areas where you can still encounter hazardous potentials. Examples of these will be found in television and cathode-ray tube display circuitry, laser and switchmode power

supplies, high power transmitters etc. You will need to make your own assessment of whether, under the worst possible circumstances (usually hand-to-hand contact), the potentials used could be lethal. It pays to be very pessimistic in this regard!

If you have to develop high voltage circuits, the following tips will help you avoid contact with dangerous potentials. Firstly, don't run high voltage rails in TCW, as previously described for low voltage circuits. All high voltage distribution should be by means of suitably insulated wire. Any prominently exposed high voltage points should be covered with insulation tape. All tagstrips, etc. used should be rated for the voltages applied.

Transistors operating at high potentials should be electrically isolated from their heatsinks, or if this is not possible the heatsink should be mounted in a way which will reduce the chance of accidental contact.

Don't touch the circuit at all (except with instrument probes and adequately insulated adjusting tools) when high voltages are applied. After you switch off, short out any capacitors which may have retained a charge. To make this action automatic, the design should incorporate suitable bleed resistances. Make sure that any test and measurement equipment is adequately rated for the voltages to which it will be exposed.

If you have to measure or adjust something when the circuit is powered up, use only one hand for this purpose and keep the other hand behind your back. Make sure that any other part of your body cannot make contact with the other side of the high voltage supply. For example, if the other side is earthed, standing on a concrete floor with bare feet is not very smart!

If there are others working nearby, don't wander off and leave power applied to an exposed experimental circuit. If somebody 'zaps' themselves on it, you could be held legally responsible. If you have to leave something operating, make sure that the area is secure and adequately signposted.

For obvious reasons, don't work on high voltage circuits alone, if at all possible.

### Mains safety

Apart from large transformers like those found in big transmitters and microwave ovens, the AC mains is one of the most dangerous things that you will encounter. Believe me, this is one devil that you do NOT want 'shake hands' with!

Not only is the mains potential sufficiently high to push a lethal amount of current through an unwilling resistance (that's you!), but the impedance of the supply is very low and the explosion resulting from an inadvertent short circuit can be quite violent. ALL of the warnings given in the previous section on high volt-

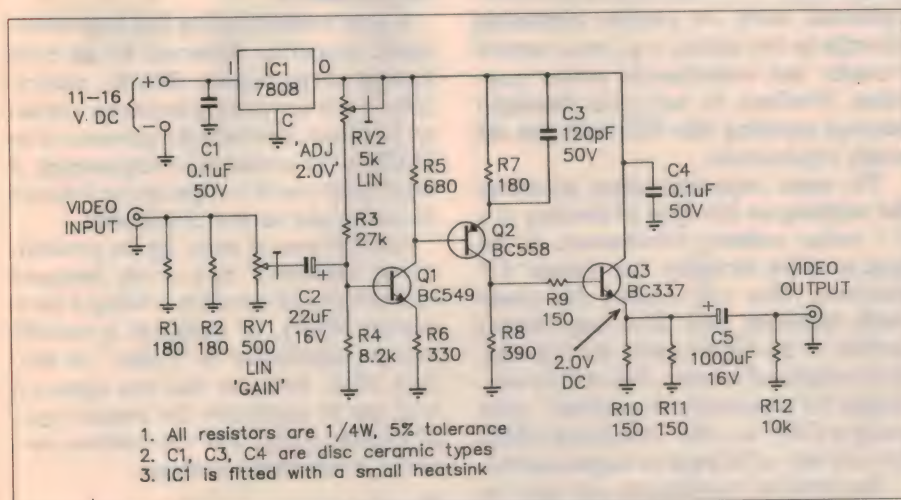
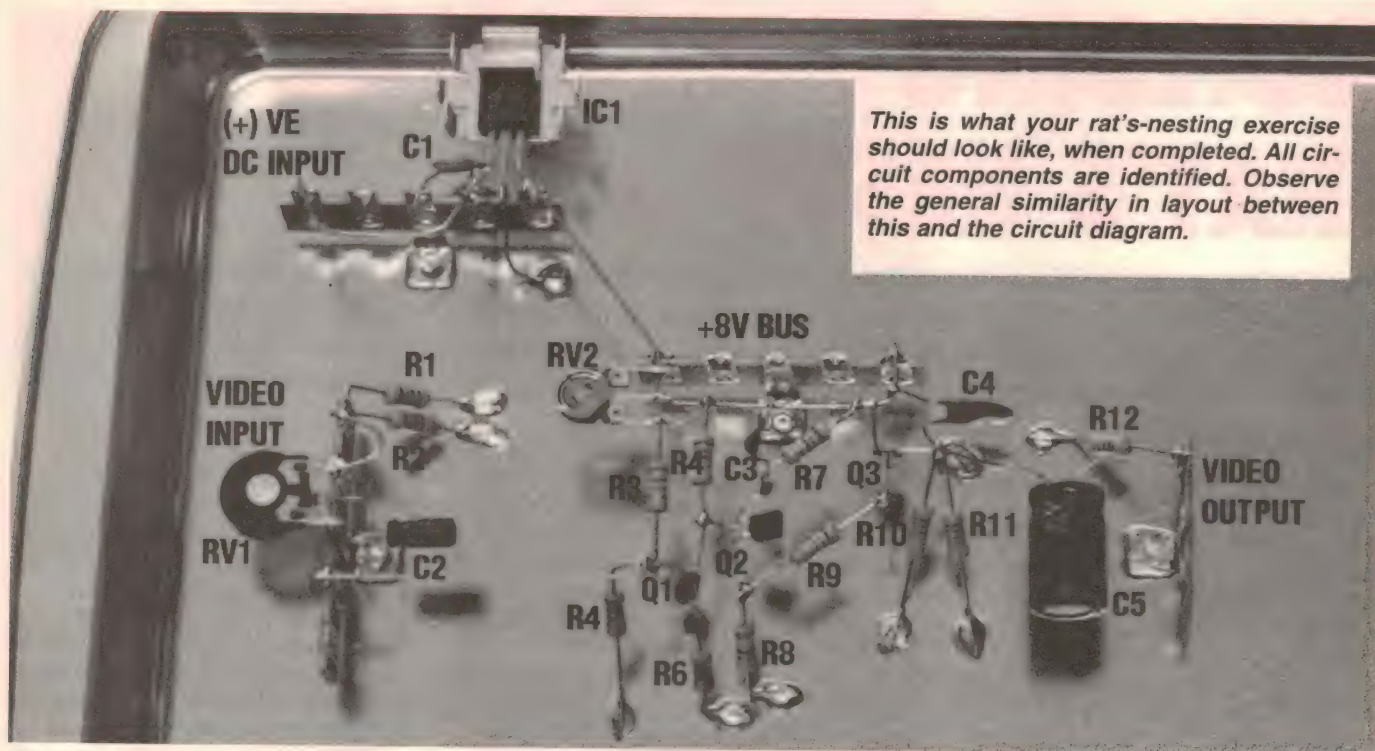


Fig.2: This circuit schematic diagram for our sample rat's-nesting exercise, a video amplifier. If you compare it with the photograph of the finished 'rat's nest', you will see that the layout in each is very similar.





*This is what your rat's-nesting exercise should look like, when completed. All circuit components are identified. Observe the general similarity in layout between this and the circuit diagram.*

age safety are relevant, plus a few more!

Fortunately the mains connections in most 'lash ups' will be limited to connecting up the primary of the mains transformer via a 'chocolate block' connector, or similar. Even the top of these should be covered with insulating tape, as Murphy's Law says that any dropped component will head unerringly for the active terminal.

Even though the circuit may be only experimental, the same mains safety wiring rules which apply to production equipment should be followed. The mains cable should be firmly anchored to the chassis with a 'P' clamp or similar; the active lead should be the shortest (hence first to be severed in the event of a severe strain) and the earth lead left the longest (and last to be severed).

Transformers should be bolted to the chassis, with their frames effectively earthed. Very small transformers can be mounted with double-sided adhesive foam mounting tape, but the frame must be earthed via a separate wire. Don't forget to scrape off any varnish (if used) before attaching the earthing lug.

If it becomes necessary to include other components in the mains circuitry (like filter capacitors, surge suppressors etc.), they should be securely mounted on tagstrips rated for the full mains voltage, and the danger area should be protected by an insulating cover. Using a similar method to that described in the

first article, the presence of mains power should be indicated by a large, bright neon or other warning device.

Although a regulator IC may include overload protection, the raw filtered supply rail is generally exposed in a 'rat's nest' prototype. Transformers of any substantial size should therefore be protected by means of a suitable secondary fuse, which will blow if the supply rail is shorted. Even the humble type 2155 transformer has a flash RMS short circuit current of about nine amps!

We enter an even more dangerous phase when it is necessary to do developmental work on circuits connected directly to the mains, e.g., triac control circuits and switchmode power supplies. Needless to say, you shouldn't attempt anything like this until you are really experienced.

The most important safety accessory for working on this type of circuitry is a 1:1 mains isolating transformer, of the type used for servicing 'hot chassis' TV receivers. This will remove the mains earth reference, and allow any chosen section of the circuit under development to be connected to earth. This will be necessary for measurement purposes when using a CRO or other instrument which has one side of its input or output earthed.

An isolation transformer can also be used to limit the amount of AC current that can flow under fault conditions. For example, if you're developing a triac light

dimmer, you might want to confine your early experiments to a circuit powered by a couple of 6672-type transformers, with their secondaries coupled back-to-back.

At this stage, the load can be a 15W lamp while you do most of your 'fiddling' to get the control characteristics correct. Whilst the supply voltage will still be potentially lethal, the violence of any catastrophic failure will be limited by the regulation characteristics of the two 30VA transformers used. Once most of the developmental work has been done, the transformers can be removed and the full load connected.

It goes without saying that your workbench should be protected by an earth leakage circuit breaker (ELCB), particularly if you're working on mains circuitry. However, don't use the presence of an ELCB as an excuse for complacency; it won't help you if you get strung between the active and neutral conductors!

Another way of reducing the possibility of 'fireworks' in a newly designed mains operated circuit is to bring it up to voltage slowly, by means of a variable voltage transformer (a 'Variac', or similar). Note, however that this approach may not be applicable for certain types of circuits which will not function correctly at low mains voltages.

### A video amp project

The best way to get the 'feel' for rat's-nesting is to work through a typical exam-



ple. Fig.2 shows a simple, very low cost video amplifier which might be used to standardize the level of a video signal at 1V p-p. It could also be used as a continuously variable RF amplifier/attenuator up to about 10MHz.

The input and output impedances are 75Ω and the voltage gain is variable between 0 and 3.8 times. With R1 and R2 removed and RV1 increased in value to 1k, the circuit could also find use as a 'bridging' amplifier to drive a second video monitor when the first monitor has a fixed internal 75Ω termination that cannot be conveniently disconnected.

The unit is designed to be powered from an unregulated supply of between 11V and 16V, for example a 'plugpack'. The current drain is 42mA. Although this circuit is intended as a rat's-nesting example, you can regard it as a constructional project and build it up neatly in a box, if you have a use for it.

## Circuit description

The input signal is applied across the 500Ω gain control RV1 which, together with the parallel resistors R1 and R2, sets the input impedance at 75Ω.

Q1 and Q2 form a non-inverting DC coupled wideband amplifier, which is in turn DC coupled to the output emitter follower Q3 which drives a 75Ω co-axial cable. Note the presence of the components R9 and C4, which provide protection against possible parasitic oscillations. This type of co-ax cable driver circuit will be described in a later article, and the problem of parasitic oscillations will also be discussed.

The low gain and modest bandwidth requirement for video signals mean that very cheap transistors can be used in this circuit. C3 provides high frequency compensation by causing the emitter load impedance of Q2 to decrease with increas-

ing frequency. The HF response at 1V p-p into 75Ω is less than 1dB down at 5MHz, and less than 3dB down at 9MHz.

IC1 provides a regulated rail of approximately 8V for the amplifier. C1 provides input HF bypassing for IC1 because the power supply may be some distance away. Since the circuit will be physically compact, C4 will suffice also to bypass the output of the regulator.

## Construction

Referring to the photograph, the first components to be installed are those associated with the regulator IC1, which is fitted with a small heatsink. These components can be seen mounted on the tagstrip at the rear on the left hand side.

Because the output terminal of 78/79 series TO-220 regulators is on the right hand side, I usually mount them on the right of a five-lug tagstrip, and leave the two lugs on the left for the programming resistors or adjustment trimpot, if used. Note the positioning of the input bypass capacitor C1. The 8V output from the regulator is linked via TCW to the centre tagstrip, where the rail bus is arranged in a similar manner to that shown in Fig.1 in the first article.

At centre left a five-lug tagstrip is fixed to mount the gain control RV1, the termination resistors R1 and R2 and the input coupling capacitor C2. This tagstrip also provides a termination point for the input signal co-ax cable. Since sockets would not normally be mounted on 'rat's nests', it pays to have a good selection of suitable interconnecting cables on hand. These should have an assortment of plugs (mostly BNC types for RF/video and RCA types for audio) on one end and stripped leads on the other, for connection into the 'rat's nest'.

The circuit of the amplifier itself is

built around the centre five-lug tagstrip. The first component to be installed is R5, followed by Q1, R6, R4, RV2, R3 and the link to C2 in that order. The base of Q2 is attached to the collector of Q1, and then R7, C3 and R8 are added. The collector of Q3 is then attached to the TCW 8V rail, leaving sufficient space for R9 which must be connected between its base and the collector of Q2.

R10 and R11 are then added, which will firmly anchor Q3 in position. C4 (the collector bypass capacitor for Q3) is the next to be installed, as close as practicable to the collector of Q3.

A three-lug tagstrip is soldered to the chassis on the right, to take the negative end of C5 and also to act as a termination point for the output co-ax cable. Finally, C5 and R12 are installed.

The above assembly is carried out using the 'tack first and fillet solder later' technique described earlier. It can be seen that Q1 and Q2 are supported by six leads each and Q3 is supported by five leads, so the whole construction is really quite rigid.

If you compare the layout in the circuit diagram to the layout in the photograph, you will notice a striking similarity between the two. A well laid out circuit progresses logically from input to output, and this is generally also the best arrangement for hard-wired or PC board construction.

## Testing

Since this amplifier is DC coupled, its 'health' can be checked easily by measuring the DC voltage at the emitter of Q3. If this can be set to 2.0V by means of RV2, then the wiring of the amplifier itself is almost certainly correct. Provided that you've installed the electrolytic capacitors the right way around, the circuit should then be fully functional. C3 can be varied, if necessary, to achieve an optimum square wave response at approximately 100kHz.

When building 'rat's nests', you can take the opportunity to use up all those components you've accumulated over the years which may be in good condition or even brand new, but don't conform to the current shape or size requirements. As an example, the circuit shown uses half watt resistors because I've got an awful lot of these.

In the next of these articles we'll look at a full constructional project, in which you can put your rat's-nesting skills to the test by building an 88-108MHz FM audio transmitter with some nice features that the 'cheapie' designs leave out.

(To be continued.) ♦

## PARTS LIST: Example Video Amplifier

<b>Resistors</b>	All 0.25W 5%: 1 x 27k, 1 x 10k, 1 x 8.2k, 1 x 680, 1 x 390, 3 x 180, 3 x 150 1 5k vertical-mounting trimpot (large) 1 500 ohm vertical-mounting trimpot (large)
<b>Capacitors</b>	1 1000uF 16V electrolytic 1 22uF 16V electrolytic 2 0.1uF 50V disc ceramic 1 120pF 50V disc ceramic
<b>Semiconductors</b>	1 7808 regulator IC 1 BC549 NPN transistor 1 BC558 PNP transistor 1 BC337 NPN transistor
<b>Miscellaneous</b>	1 'Willow' brand Biscuit Slice Tray or similar, 285 x 185mm 3 5-lug (centre earth) large tagstrips (10mm pitch) 1 3-lug (centre earth) large tagstrip (10mm pitch) 1 TO-220 clip-on heatsink 2 BNC cable sockets 75Ω co-axial cable, hookup wire, 22SWG (0.71mm) TCW



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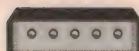
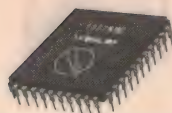
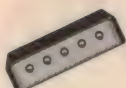
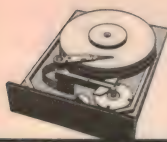
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## Bletchley Park

*Continued from page 33*

By the commencement of the Second World War, the system that was used by the Germans to carry out cyphering of written messages involved a systematic jumbling of the letters using a machine to simplify and speed up the process. The Enigma machine employed a cypher key that repeated so infrequently that even a fast modern computer, carrying out a reverse process of testing alternatives, would take so long to find an answer as to make the translation of the message far too late to be useful.

This encoding process as undertaken by the Enigma machine was thought by the German forces to be unbreakable. In a technical sense and at that time, they were probably justified in their assumptions. However as it turned out there was more to decyphering long repeat key messages than a simple process of brute-force testing of every possibility.

In fact it was through a combination of techniques that the messages were broken. Part of the technique was based on making use of the errors and misdemeanours of the cypher clerks who carried out the encyphering process.

Apart from this however, what the Germans did not fully appreciate was something that was very effectively stated by the mathematical genius, Alan Turing — the author of the historically important paper on 'Computable Numbers'. This paper was in large measure responsible for setting the foundations of modern computer programming, based on binary numbers rather than more conventional decimal notation.

As Turing said, in effect, "If one can build a machine to produce a complex structure, then it is inevitable that you can build another machine which can unravel the complexity". In the case of the German encoding system, based on the Enigma machine, it was the Polish codebreakers, in the 1920's — using a combination of mathematics and simple machinery — who first demonstrated that the proposition of Turing could be correct.

What is now known by all cypher users is that there is in reality only one absolutely safe and unbreakable method of encoding a message. Even with the emergence of systems such as that embodied in PGP (Pretty Good Privacy) and now seen on the Internet, if one wishes to be absolutely sure that what one wishes to hide cannot be read by an unwanted third party, it is to the 'one-time pad' system that one must turn. This is described in the accompanying panel.

*(To be continued.) ♦*





# INFORMATION CENTRE

by PETER PHILLIPS

## Series lights, video tapes & pest deterrents

There's our usual range of topics this month, starting with a close look at an electronic pest deterrent we have mentioned in past issues. There's also letters about our February over-speed monitor, why video tapes wear out, how series-connected lights remain working with one or more lamps blown, and more.

In previous issues I made mention in this column of an electronic device claimed to get rid of insects and other pests. In January I described the device as 'consumerism at its worst', on the basis of its 7W power consumption and the claims made in an advertisement sent to me by a reader. However in March I had to retract somewhat, when another reader pointed out that the device had eliminated ants that had previously plagued his kitchen for 20 years or more. Now I need to retract even further, as the manufacturer of the product has sent me considerable evidence of the device's effectiveness. I also now have a sample of the product.

Before I explain further, I'm sure the views I expressed about the device are likely to be held by many readers. After all, we technical types are a cynical lot, as we know the sort of claims that are often made about 'electronic' gadgets. In many cases the claims are misleading, even outrageous, and yet people will buy the product as their technical understanding is insufficient to make them question the claims. As a technical publication, our role is to help counter this sort of thing, where we can.

But when we are wrong, we are happy to admit it, and to put things right. So let's do just that, for what appears to be a most effective way of getting rid of pests.

### Pest eliminator

The device is known as the Pest Free, and retails for around \$80. As the photo in Fig.1 shows, it looks rather like a plugpack, although somewhat larger. It measures around 100 x 40 x 55mm and consumes 7W. The product is Australian made, and is based on a design developed in 1978 by an American poultry farmer who was

pestered by rats. This design proved effective, and has been available commercially in the USA ever since.

It was introduced to Australia in January 1995, under licence, by an Australian company called Pest Free Australia. The owner of the company had purchased the US version in 1991 for use in his home. He was so impressed with it that he decided to release an Australian version, which involved a further three years of development.

According to the company, the device doesn't create any electromagnetic (EM) radiation. Instead it pulse modulates the existing background EM field caused by the electrical wiring in a house. It's the pulse modulation that is said to affect the sensory systems of pests in the area. This doesn't always kill the pests; instead it causes them to seek another place to live, away from the EM field. One device is said to be enough for the average home.

Now to the evidence. Pest Free Australia has not had an easy road, as people like me have bucketed the device, making it difficult for the product to gain credibility. To counter this, the company has commissioned research on the device, and has kept a file of letters from purchasers.

I received copies of over 80 letters confirming satisfaction with the Pest Free. Included is a letter from a pest exterminating company that now offers the product as an alternative to chemical methods. Another is from a hotel in India, saying *the device has proved more effective than other methods used hitherto...*

Others are from clubs, food shop and restaurant owners, canteen operators, school principals, home owners and so on. I'm not going to quote from every letter, as they all say much the

same thing: *the device really works*. Typical comments refer to the device getting rid of cockroaches, ants, rats and spiders. As well, most people comment about no longer needing to use pesticide chemicals. Quite a few letters admit to initial scepticism, but all go on to give glowing praise.

At the time of writing, I can't mention the name of the university Pest Free Australia has commissioned to do research on the device, but I can quote from an initial report: *The preliminary results of stage one have been finalised and conclude that its value as a deterrent to rats seems quite clear*. This was based on observations of the amount of food consumed (by rats) when the Pest Free units were operating and not operating, showing 'statistically significant differences'.

Pest Free Australia has also had the product tested by the department of Health and Family Services (formerly Australian Radiation Laboratory), which asserts that it has 'no affect on humans and pets'. The device is certified to AS/NZ1044:1995 by EMC Technologies Global Product Certification, with a C-tick approval. It also meets the required Australian Safety Standards, with certificate number CS6455N. So, what more can I say?

Quite clearly there's plenty of evidence that this compact device actually works, in some cases better than sprays and other chemicals.

But perhaps you're thinking I'm saying all this under pressure, following my 'consumerism at its worst' comment. Not so! The company is used to this sort of put down, and rather than embark on legal proceedings, it offers the kind of evidence I've just presented. You might even remember the company being taken to task by *A Current Affair* some time ago.

We do like to support Australian



companies, but as you'd expect, only if the company has a product that works. In this case, it's clear my comments in January were based on insufficient information, and I should have made further investigations first. However I suspect that others in my position would have said much the same thing.

So far I've not had the sample unit long enough to evaluate its effectiveness, but going on the evidence I've presented, it seems clear I don't need to.

Another interesting aspect to this device is its manufacture. Apparently, despite the setbacks Pest Free Australia has had, sales are escalating, keeping a number of sheltered workshops very busy. According to the company, the device is made entirely in Australia, and judging from the sample I've received, is well made. It has a three-year warranty and a 30-day money back guarantee. The manual supplied with the unit gives lots of information, detailing the user's role in minimising pest infestations, and explaining the limitations of the device. For instance, it takes several weeks before you start to notice any effects.

So there it is, an electronic pest eliminating device that does seem to do all it's claimed to, despite its modest power consumption. There's also a commercial version for larger premises.



**Fig.1:** Despite its small size, the Pest Free seems to be able to protect the average home from pests ranging from ants to rats.

es. For further information contact Pest Free Australia on 1800 678 005, or write to PO Box 42, Newcastle 2300. And of course I'll be most interested in hearing from readers who install this device.

## Gold and silver

This short message was put on our bulletin board, in the hope that we or other readers could help:

*I am seeking information about recovering gold and silver from electrical and electronic components. Do you know of anyone that can help me? (Trevor Dasecke, BBS)*

Unfortunately we can't, Trevor, but perhaps readers might be able to.

## Overspeed monitor

The next letter makes a few suggestions about the overspeed monitor we published in February '97. It's from a reader who has used similar devices for some years. I've condensed the letter, which also describes a rather novel way of letting you know when a preset speed is exceeded. I'll explain after the letter.

*Concerning your overspeed monitor, I have a few suggestions readers might like to consider. The first is a must — an on-off switch to avoid being driven crazy by the device. Another is a switching method to select one of a number of speeds, rather than manually setting the speed with a potentiometer. I have used two different systems, both similar in operation. In both cases the equivalence of the R5-VR1-R7 network in your project was replicated with separate resistive networks, selected by a switch. One of these networks can be left as a front panel adjustment to cater for speeds other than those offered by the preset networks.*

*A short delay might be needed to prevent the unit beeping when you select a network. In fact, a delay of a few seconds before the unit sounds is a good idea, as you don't generally need instant indication when you are exceeding the speed limit. I also found a volume control very useful (which will make the suggested on-off switch redundant). And finally, if there is any chance the unit will be transferred from one car to another, build the alarm speaker into the box. This avoids finding space behind the dashboard (impossible in many of today's cars), and running wires. (Ron Voller, St Georges Basin, NSW)*

Thanks for these suggestions Ron, which — it would seem from your let-

ter — are based on considerable experience. As I've already mentioned, Ron designed a cruise control 'of sorts' which he used in several cars. This system let the driver know when a particular speed was exceeded by pushing the accelerator pedal against the driver's foot. No alarms, just a kind of mechanical feedback, which being spring activated could be overridden if necessary. Cunning!

## Light strings

Here's another letter from our BBS, which concerns Christmas tree lights. Do you know how they work?

*This is probably no longer topical, but I'm curious how those cheap 240V Christmas tree light strings work. I'm referring to those that don't have a transformer, cost around \$20 and have about 40 miniature lights. While they appear to have the lights connected in series, they continue to work even if one of more lights blow. Is there some other conductor in the light assembly?*

*This Christmas I noticed the lights on our tree suddenly all went off. A little later they all came on again, briefly, then off. The next day I decided to check them to see what had happened. After finding one, two, three lights open-circuit, it became obvious that all lights were blown. It was also obvious that they'd overheated, as the plastic carriers showed signs of melting. Can you explain how these lights can work with one (or more) of them open-circuit, and why a whole string failed simultaneously? (Bob Moroney, BBS)*

I haven't examined these light strings Bob, but I think I know what's happening. It used to be common practice with series-connected lights to fit some type of device inside each lamp socket (or lamp) that breaks down when there's 240V across it. This device then becomes almost a short-circuit and remains so.

A 240V light string of 40 series-connected lamps must contain 6V lamps. If one lamp blows, there will be 240V across it which will cause the device inside the lamp to breakdown and conduct. This will leave 39 lamps operative, each with slightly more than 6V across it. If another lamp blows, the same thing occurs, with each remaining lamp having even more voltage across it. Eventually more lamps will fail because the voltage across them now well and truly exceeds their rating, until all lamps are blown. There must be a point at which this happens quickly, as you experienced.



While writing this, I'm reminded of an event etched forever in my mind. Many years ago my father decided to highlight a large roadside sign by giving it a border of 1.5V torch lamps, all connected in parallel. He had a rather amazing looking transformer which had a 1.5V 50A secondary to drive the lamps. It also had taps on the primary.

He soldered each lamp in place, on the basis that if a few of them blew, it would not affect the others, so there was no need for sockets. In all he fitted over 100 lamps, taking days to do so. After doing all this, he applied power and we were gratified at seeing the sign light up, which according to others, was visible up to 10km away. But Dad wasn't satisfied!

The next night he decided to try another tapping on the primary, to increase the voltage to the lamps. It took about 10 milliseconds for every lamp to blow. Not to be put off, Dad bought another 100 lamps and replaced the 100 dead 'uns. Unfortunately, he forgot about having changed the tapping on the transformer. You guessed it: another 100 lamps flashed on briefly, then went off — forever. After that, he gave up!

## Video tape failure

In January a reader asked about reversing video tapes, so the rarely used end would become the start, spreading the wear more evenly over the tape. The next letter is from a reader who has done this, with little success it seems. Perhaps the problem is video tape ageing rather than wear...

*I have tried reversing worn video tapes, as suggested by your correspondent in January 1997. I couldn't think of a way of using the cassette or of modifying a cassette, as you have to detach the full spool and turn it over before rewinding.*

*Briefly, I made a special winder which took one spool, upside down. After rewinding, you detach the leader from the empty spool, turn the spool the right way up, and re-attach the leader, then reassemble in the cassette. All quite a lot of work. The result however was not what I expected, and I now think the problem is not wear on the tape, but general deterioration which equally affects both ends. This assumes the VCR is properly maintained.*

*An article in 'New Scientist' (21-28 Dec 1996) discusses deterioration of*

*modern plastics, and says about video tapes: 'if they are more than five years old, get them copied now'. It describes why tapes fail, and why they are not a satisfactory archiving medium.*

*I presume most magnetic storage materials suffer the same deterioration, but I have seen little discussion about this. Perhaps EA could look into it. If the tape is mechanically damaged, I suggest the easiest way to repair it is to shorten it by removing the damaged part. There are video tape splicing kits available. (Max Burnett, Otaki Beach, NZ)*

We probably tend to take modern plastics for granted. We forget when plastic buckets lasted about 12 months, and when pliable plastics would, over time, become as hard as a brick. I haven't read the article you mention Max, but I'm sure the plastic used in a video tape could stand further improvement.

I regard video tapes as being relatively dispensable, as their cost compared to that of a VCR is quite low. Repeated use must eventually cause tape wear, but ageing is certainly likely to be a more significant factor, especially if it means loss of the magnetic material. So perhaps the best answer, for now, is to regularly replace video tapes, rather than try and repair them.

## LP recordings

This letter is also somewhat related to video tapes, in that the writer wants information about making audio recordings that last for several hours. The writer admits to being rather out of touch, but is apparently anxious to remedy that:

*I have been away from electronics for some time, but I now want to get more involved again. One area of interest to me is making audio recordings that are not limited to the hour or so available from a typical cassette. Although I might be living in the dark ages, I wonder about a reel to reel tape deck. It occurred to me that I could even build one, as the cost of a new one is more than I want to pay at this time. I would appreciate it if you could give me the names of possible suppliers for parts for such a project.*

*I also need an electronic timer to control a small electric motor. I want the timer to be intermittent, variable and random. (Phil Goodwin, Bowral, NSW)*

These days, Phil, you should be able to pick up a second hand reel to reel tape deck for virtually nothing. I recently chucked out a perfectly good three-head unit, as no one seemed interested in it — even as a gift. I don't recommend trying to build one, as apart from the mechanics which you would need to buy, you'll find the electronics quite involved.

A possible solution is to use a video tape recorder. Most VCRs (particularly hifi types) have a facility for audio recording. A conventional stereo (not hifi) VCR records audio tracks in much the same way as a reel to reel deck, although because of the lower tape speed, the quality is not as good. A hifi VCR can give up to eight hours of audio recording, with a better sound quality than either a cassette or a reel to reel tape recorder.

Concerning timers, I suggest you look at our Flexitimer Mk 2, published in August 1995. This timer is relatively simple, but has lots of options as to how it's used. Other timers we have published include a Weekly Reminder Timer (April '94), a Simple Universal Timer (February '90) and a Timer/Controller for Garden Sprinklers (October '89). You'll need to connect the timer to a relay, which in turn operates the motor.

## Transformers

The next letter asks a few questions about transformers and the nature of the current at switch-on.

*I am wondering what happens when power is first applied to a transformer, such as those used in many hobbyist projects. If the voltage is at its peak at switch on, surely the conditions will be different compared to the voltage being at zero. Does the nature of the load affect these conditions? For example if the transformer is supplying a rectifier, surely the conditions are different if the capacitors happen to be charged at switch on, compared to them being discharged. Does the load on the secondary influence the apparent inductance of the primary?*

*I've never seen much comment about this sort of thing. (A. Brooks, North Mackay, Qld)*

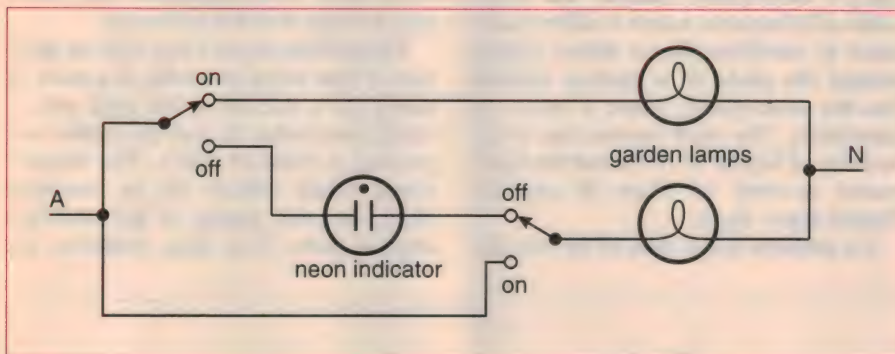
Despite the simplicity of a transformer Mr Brooks, the fine details of its operation are quite complex, especially when taken from the instant of switch-on. Basically, the current taken



by the primary of a transformer is magnetising current (a fixed value) plus the current required to sustain the secondary current, which depends on the turns ratio. The magnetising current is needed to sustain a magnetic field in the core and is the current taken from the supply when the transformer is unloaded.

At switch-on, because the transformer is essentially an inductance, the current will rise sometime after switch on, visible on a 'scope as a current out of phase with the voltage. But the load on the secondary will effectively reduce this inductance, bringing the current more in phase with the voltage. So yes, the secondary load does influence the inductance, and quite considerably.

If the load contains large value filter capacitors, these will appear as almost a short-circuit, so the initial current will be quite high. In fact, this can often cause a transformer (or rectifier diodes) to burn out, as the charge current is limited mainly by the DC resistance of the secondary winding. To avoid this, it's usual to fit low value resistors in series with large value filter capacitors.



**Fig.2: The solution to the March What?? problem. We didn't say that the neon had be ON when the garden lights were, did we?**

If the input voltage happens to be maximum at switch-on, and if the load is connected to the secondary, there will be a greater inrush current than if the voltage is zero. In most cases the transformer will cope, providing its rating is adequate, so we can generally ignore the first few cycles of operation.

If the transformer primary is connected to the mains via a solid state relay, power at switch-on will always be applied to the transformer at the zero crossing point of the input voltage, which can help to an extent. But it really comes back to correctly rated parts.

## TV advert eliminator

Some years ago, while feeling mis-

chievous, I wrote a totally fictitious article for our April Fool's page. The article described an IC able to detect TV advertisements, by responding to typical catch phrases like 'don't send any money'. But it seems there could be such a device available, except it relies on a different principle. And no, this is not an April Fool's trick. The enquiry comes from our BBS.

*Some time ago an article was posted on your BBS about 'annoying' TV commercials and mentioned a device able to remove these. I remember reading that the device measured the video signal, and when it detected a one-volt frame (black screen), it would toggle the pause button on a VCR to prevent the ad being recorded.*

*Where would I find more information about measuring the audio/video outputs of a VCR to find a one-volt frame? Also, are you aware of this device? (Adam Baker, BBS)*

None of us knows about this device Adam, although we are all most interested. I always record any TV programs I want to watch, so I can fast forward through the ads. But I'd love a device that could stop the VCR recording these.

Regarding a 'one volt' frame, I wonder if this is a reliable way of indicating a forthcoming commercial. There are lots of times when a black screen occurs, not just before or after a commercial. But let's assume this method works.

In the first place, the device would need to store a complete frame and confirm that each line is at black level, ignoring noise. This is probably easy enough with today's ICs, but would need quite a bit of number crunching. After that, it would simply produce an output signal that could be used to control the pause function of a VCR, perhaps through its remote control.

Another less reliable but cheaper

way could be with an integrating network (resistor and capacitor). Here the video signal is fed directly to the network which has its RC values chosen to cause the voltage across the capacitor to reach a specified value after an appropriate number of all black frames. Tricky, but possible.

To see a complete frame on a 'scope, you need to connect it to the video output of the VCR, and set the sweep rate to around 5ms per division. If all lines in the frame are at black level, all you'll see will be the horizontal sync pulses and colour bursts riding on the black level, which is probably around 1V. If you are seeing this in real time, you'll have to be quick.

## What??

This month's question seems at first to be impossible. But trust me, it's easy enough. It comes from Charlie Worsfold, who contributed the February What?? question.

*A customer enters a shop and sees a number of transistors in a basket. The customer takes half the transistors, plus half a transistor, pays for them and leaves. A second customer enters, sees the remaining transistors, takes half of them plus half a transistor, pays and leaves. A third customer enters, sees the remaining transistors, takes half of them plus half a transistor, pays and leaves. There are no transistors left, and no transistors were actually cut in half. How many transistors were there in the first place?*

## Answer to March's What??

The circuit is shown in Fig.2. Yes, it's a bit of a trick question, as it didn't specify that the neon indicator had to be ON to show if a garden light was on — only that it should indicate! In the circuit, the neon is OFF when either one or both garden lights are on. In practice this is rather unfriendly, but that's not the point; it does indicate the garden light status. ♦

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# SPACE JUNK: A GROWING PROBLEM

There's now a surprising amount of debris orbiting around the Earth, in addition to the 'live' satellites in current use. This orbiting junk is starting to pose a serious risk for new satellite launches, as well as space missions. The 'natural' cleaning mechanisms are too slow to be of much help, as the author explains...

by **GEOFF McNAMARA**

When Sputnik 1 was launched in 1957, the world stared in awe at Russia's — and more generally, man's — long dreamt-of ability to reach out into space. At the time, space seemed limitless, a void to be explored and exploited. In the 40 years of the space age, however, spacefaring nations have begun to realise that space isn't so big after all.

In particular, the orbital space immediately surrounding Earth is becoming increasingly congested with space hardware: live and dead artificial satellites, and a variety of associated debris.

For now, the hazard of satellites being damaged or destroyed during a collision is slight, but the risk is growing — posing a threat not only to the space industry, but to a world increasingly dependent on artificial satellites.

Since Sputnik, over 4500 spacecraft have been launched from planet Earth. Of these, only a handful have ventured further than the Earth's immediate environment. The vast majority have remained in Earth orbit, offering a variety of services from scientific assessment of the Earth's environment to the facilitation of mobile phones.

Satellites tend to return to Earth under the dragging influence of the Earth's atmosphere: of those launched, an estimated 2200 spacecraft remain in orbit, of which only about 450 are still operational. In the last four decades humans have added some 10,000 objects larger than a cricket ball, and literally billions of smaller particles, to near-Earth space. Any of the smaller objects could cause severe damage to an operating spacecraft; objects larger than a marble could destroy a satellite.

When a satellite ceases to function it is seldom recovered. Although the dream of the space shuttle was its cost-cutting ability to retrieve satellites for repair and later redeployment, this seems unlikely to be realised for a long time. Currently when a satellite stops

operating, its functions are taken over by a new satellite. The old satellite is left to wander aimlessly and silently.

Space debris consists of more than simply a growing number of disused satellites, however. When a satellite is placed into orbit, for example, restraining bolts and lens caps have in the past been set free to wander through space. In addition, so far some 120 spacecraft and rocket bodies have broken up in orbit, with their remnants flung far and wide in untraceable orbits.

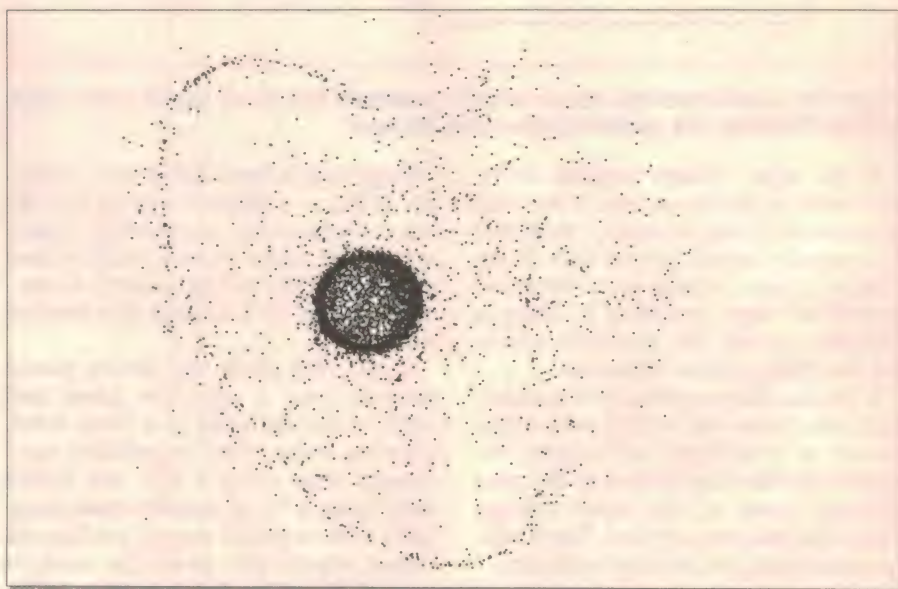
Admittedly, Earth orbital space is, to a certain extent, self-cleaning. The Earth's atmosphere reaches out thousands of kilometres where it offers resistance to satellites. Space debris spirals around the globe in a gradual decline into the atmosphere, where it burns up harmlessly. The most famous case is the re-entry of Skylab in 1978, and the more recent re-entry of Mars 96 and its flawed upper stage.

The problem is that most of the time the

process is painfully slow. Although the atmosphere theoretically reaches great heights, its effect on claiming satellites declines quickly at higher altitudes.

For example, if all satellite launches were to cease immediately, there would be a 50% reduction in the amount of junk in orbit at 800km within five years, and 100% free of debris after 100 years. At 1500km, however, and this is not an especially high orbit, there would be a negligible cleansing effect after five years, and only a 15% reduction in space debris after a century had passed. At the popular geosynchronous orbit some three Earth-diameters out, satellites remain aloft for *millennia*.

The problem doesn't stop with the addition of new items into orbit. If a piece of debris hit a satellite at the right spot, it could conceivably destroy the satellite and produce a cloud of debris. The shrapnel cloud would initially fly in formation along an orbit similar to the satellite's original path. Over time, however, the



**A diagram showing the location of catalogued debris orbiting the Earth. (Courtesy Kaman Sciences Corporation)**



gentle gravitational tugging of the Moon and Sun would spread the cloud of debris into a larger volume, eventually forming a torus around the Earth. This creates a greater risk of the debris encountering yet another satellite — or satellites. A new collision with a fragment from the first satellite could repeat the process of satellite destruction, creating yet another cloud. That cloud would then go off in search of yet more satellites...

The process is called fratricide, an old term meaning the killing of one's own brother. The fear is that, while the process has so far only been seen on a small scale, there is concern that the rate of satellite fratricide will become exponential. With time, it's conceivable that entire orbits could become so risky as to be uninhabitable.

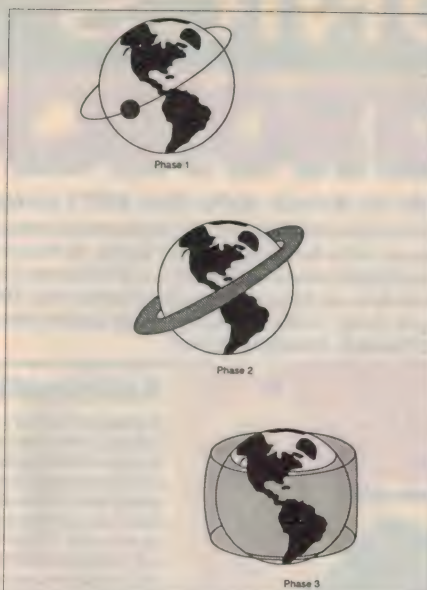
(The Soviet satellite Kosmos 1275 is suspected to have been destroyed by a collision with debris. In similar fashion, the Small Expendable Deployment System tether was presumably cut by debris in 1995.)

## Kessler's Syndrome

The worst scenario so far described was put forward by now-retired NASA scientist Donald Kessler. According to the Kessler Syndrome, as orbits under 1000 kilometres altitude become unsafe, astronauts would have to fly to even higher orbits. The problem is that the cleansing effects of the Earth's atmosphere don't work at these higher orbits and so the space junk stays put, clogging the region indefinitely. At even higher orbits — say above 5000 kilometres — astronauts would be exposed to the lethal effects of the radiation belts. To go to even higher orbits is too expensive, and so in effect, we'll have priced ourselves out of space. This scenario, says Kessler, could be played out within 30 years.

So what can be done? Artificially cleaning Earth orbit of debris is a technical and economical impossibility. The best thing to do at this stage is recognise that there is a potential problem and stop it before it starts.

Fortunately, most spacefaring nations agree that the problem is real and are prepared to take steps to reduce the proliferation of orbital debris. Such steps can be as simple as tying lens caps to the satellite so that, once released, they remain with the satellite and don't go off on their own to cause trouble. Unused fuel in upper stages can be vented to avoid explosions. To prevent satellites becoming redundant due to impact, and therefore alleviating the need for yet more spacecraft, vital components of a satellite can be shielded.



**Gravitational tugging gradually spreads the debris into a torus-shaped 'cloud' around the Earth.**  
(Courtesy Kaman Sciences Corporation)

Such steps must be multilateral, however. The concern among poorer nations is they don't want to do anything that might make them less competitive with their more established competitors. Steps taken must be, therefore, carefully reasoned steps that all nations can adopt simultaneously.

The proliferation of satellites in Earth orbit is only going to increase as we become increasingly dependent on satellite communications and imagery. Projects like the Iridium constellation of 66 satellites, and the record-breaking Teledesic constellation of 840 satellites means there is a price to pay for being able to talk to anyone from anywhere in the world.

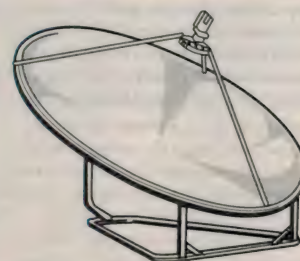
Even more frightening are such proposals as an inflatable 400m by 1000m billboard in a 300km orbit. While the idea was rebuked — most notably by astronomers who claimed it would be like having a second full moon to contend with — it could be an indication of the recklessness with which humans are tramping through space. Unless we tread more softly, we could be confining future generations to Earth.

While the problem of space debris is not yet considered to be serious, like other forms of environmental pollution the effects remain hidden for a very long time. By the time the problem becomes apparent, however, it is incredibly difficult to fix. ♦

*Geoff McNamara is a freelance science writer based in Sydney, and a frequent contributor to EA.*

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# ALTRONICS

# 1997

## Electronic Components Catalogue

### Watch Out for the Release of Our New 1997 Catalogue

We are proud to announce the Altronics 1997 Engineering Catalogue, due out in May will contain even more fantastic products and greater value for money than ever before. So be sure to get your copy.

We still offer the technical assistance that only a staff of electronic enthusiasts like yourself is able to give. Of course, in addition to this we have our Famous Overnight Australia Wide Delivery with Credit Card phone orders up to 4pm (E.S.T.) Monday to Friday. Quality products at direct import prices, means you save up to 50%!

Regards, Jack O'Donnell, Managing Director

## Digital Multimeter Kit

**"How cheap can you get? This little digital multimeter has no less than 19 ranges, including resistance, transistor gain measurement & 10 amp DC range, all for just under thirty dollars." Silicon Chip Magazine June 1995.**

Without a doubt the trusty multimeter is the most used piece of test equipment in everyday electronics! This fantastic meter includes all the parts required to complete a fully operational digital multimeter. Even the test leads and battery are supplied! With proper care this quality multimeter will last for years. Features: • 19 ranges • Transistor tester • Diode check • 5 DC current ranges (200µA-10A) • 5 resistance ranges (200Ω-2MΩ) • 5 DC volts ranges (200mV-1000V) • 2 AC volts ranges (200V & 750V)

**Note: At this price, not available from resellers!**

K 2400 Was \$29.95, NOW Only **\$14.95**

## Megger Meter Kit

(See EA May '89) This design of an electronic meg-ohm meter features a dual voltage of 500 and 1000V with a large scale meter. It can resolve resistance from 1M to 200M ohm which is ideal for insulation testing

**A must for checking earth leakage etc.**

K 2555 Normally \$79, Now **\$69.95**

## Signal Checker Kit

(See EA Aug '93) If you have ever tried to fix a circuit without a schematic, you'll know how frustrating it can be. This kit can provide you with an indication of the difference between a faulty unit and another, functional unit. It has two sets of probes, which are connected to the same relative point on each circuit. The meter then gives an indication of any differences between the circuits. **SAVE 50%!**

K 2563 Was \$39.95, This Month **\$19.95**

## The SCREECHER

### Car Alarm Kit

A very simple, yet extraordinarily effective deterrent to car thieving persons. Controlled by a hidden switch inside your car, this alarm will sound an ear-piercing 110dB piezo siren inside your vehicle when tripped, making life very uncomfortable for anyone there! Features exit and entry delay, with a soft three second pre-warn in case you forget to deactivate it, a super bright LED warning lamp and two trigger inputs. A budget alternative to commercial car alarms!

K 4360 Normally \$29.95, NOW **\$19.95**

## Lab Power Supply Kit

**3-50 Volts at up to 5 Amps**  
(See EA May '85) This supply has been one of our most popular. It includes the latest refinements and is now housed in a tough 'ABS' instrument case. This compact version uses a high efficiency toroidal transformer resulting in less heat and weight. It features dual metering for precise monitoring of the output voltage and current, and switchmode output technology for low ripple output. Supplied with fully screened and punched front and rear panels. **Specifications:** • Output Voltage: 3 to 50V DC • Max Output Current: 5 Amps • Floating Output • Ripple: Less than 5mV • Regulation 0.6% @ 20V

K 3300 Normally \$239.95, Now Only **\$179.95**

K 3301 10 Turn Pot for Precise Voltage Adjustment **\$29.50**  
K 3302 Independent Fixed ±12V Rails **\$15.95**

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**Checks insulation  
breakdown of motors,  
transformers, cables etc**

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theft deterrent  
for your car!**

## 2A SLA Battery Charger Kit

(See SC July '96) Powered from a 12V cigarette lighter socket, this sealed lead acid (SLA) battery charger provides up to 2 Amps charge current for 12V batteries of up to 6.5Ah capacity. It supplies an initial charging current of 2A to a discharged battery, and this current will gradually decrease as the cell reaches a fully charged state. This efficient step-up switch mode design includes reverse polarity and fuse protection and charges SLA cells to an end point voltage of 13.8V. Kit includes screened jiffy box case and cigarette lighter plug. Ideal for camping, boats etc.

K 1690 **\$39.95**

## Automatic Charger Kit for NiCads

(EA July '89) Get 100's more recharge cycles from your nicads.

It's now well known that correctly charging nicad cells greatly extends their service life. Here is a fully automatic NiCad battery charger that enables differing charge rates as appropriate for AAA, AA, C, D or 9V cells. Once the battery is charged, the unit automatically switches to trickle charge until you switch it off. It is fully featured, yet surprisingly simple. Requires 12V AC Plug Pack. Features: • Fully punched and screened case • Variable charge rate • Variable timer • Flexible and simple to use • Visual display of charge mode • Nicads cannot be over charged

K 1650 **\$39.50**

M 9120 12V AC Plugpack to Suit **\$14.50**

## PC Based EPROM Programmer Kit

(See EA Sept '93) This is a great new kit for programming EPROM's from 2716 to 27256. Compares favourably against commercial units costing \$\$\$ more. This kit puts you in the driving seat for under \$100. It is flexible enough to be able to program 12.5, 21 and 25V EPROM'S.

**Special Offer This Month:** Buy the K 9525 and receive the K 9526 software on 3.5" diskette, valued at \$19.95 absolutely **FREE!!**

K 9525 **\$97.50**

## Digital High Performance Signal Generator Kit

(SC July '90) This Digital Sine-Square Wave Generator uses high speed CMOS ICs and a digital filter IC to produce sine and square waves over the frequency range from 0.1Hz to 500kHz in four selectable ranges. It also features a 4-digit frequency readout, with an accuracy of ±2% (±1 digit), and an output level control to vary the amplitude from 0 to 1.2V on sine, and from 0-5V P-P on square wave. Less than 0.1% harmonic distortion from 0.1Hz to 50kHz, and 0.27% at 80kHz. Output impedance 600Ω, with load impedance 600Ω to infinity. The unit is short circuit protected, and also features solid amplitude stability between ranges.

K 2547 **\$155**

## LED Digital Tachometer Kit

(See SC Aug '91) Have you ever wondered how many revs your car's engine is doing at 100km/h or at any speed for that matter? This digital tachometer will tell you. It works with all ignitions from Kettering to Hall Effect systems and with 4, 6 and 8 cylinder cars. This tachometer features a bright 4-digit readout that indicates 0-9900 RPM with a resolution of 100 RPM. This unit will work with just about any ignition system. Only three connections are required to connect the unit to your car: one to the negative terminal of the coil and two for power (+12V and GND).

K 4320 Was \$34.00, This Month **\$25.00**

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## 100mm Super Carbon Fibre Speakers 2 for 1 Special!

These amazing little speakers will impress you and your friends. Carbon fibre is a new high tech material from which these speaker cones are made. Complimented with Barium Ferrite Magnets the results are simply amazing. 16 ohm voice coils make multi-speaker installations a breeze. Weather-proof design means they are fantastic for cars, boats, homes etc.

C 0643 Normally \$39<sup>95</sup> ea.

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## Rack Cases UP TO 25% OFF!

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**Features:** • Natural anodised finish • Aluminium construction with removable top and bottom steel cover panels • All dimensions conform to the International Standard • Vented lid • Individually packaged • Supplied in Flat Pack Form - Easily assembled in minutes.

Cat No.	Height	Height (mm)	Internal Height (mm)	Front Panel Finish	Normally	This Month
H 5021	1U	44	38	Natural Anodised	\$77	\$57
H 5022	2U	88	79	Natural Anodised	\$92	\$72
H 5023	3U	132	122	Natural Anodised	\$99	\$79

## Dual Alarm Clock Radio Telephone

Audio Line CRT 4

An alarm clock radio with two independent alarm time settings. The alarm, either buzzer or radio automatically mutes when the phone is picked up.

**Features:** • AM/FM Radio • 2 Independent Alarms • Snooze Facility • Radio or Buzzer Alarm • Switchable Tone or Pulse Dialling • Recall for Access to Telstra's "EasyCall" Facilities • Last Number Redial • Adjustable Ringer Volume

A 0500 Normally \$99.00 This Month **\$69**

## Keychain Laser Pointer

This novel laser pointer weighs only 45 grams, with the batteries, and comes complete with a keychain. Measuring only 61mm long by 14mm in diameter, it's not much bigger than many keys! It provides a very intense beam that can travel up to 50m, projecting a bright red dot onto the surface it is aimed at. Ideal for lectures, seminars, building sites and guided tours, and much less intrusive than a normal stick pointer. Push-to-activate operation. Uses two button batteries (included!).

**Elsewhere, pay up to \$179!**

A 0201 **\$69**

## "Easy Start" Jump Starter \$39<sup>95</sup>

A 0295

Have you ever had a flat battery and didn't have a set of jumper leads? You need Easy Start; it allows the jump starting of a car via the cigarette lighter socket. One end plugs into the "good" car's lighter socket, whilst the other end is plugged into the "flat" car's lighter socket.

Then the "good" car's engine is left running for about 5 minutes, after which the "flat" car should start. The unit has three charging LEDs to let you know when the other car is ready for a start attempt. It's clean, easy to use (even for the non-mechanically minded), and a lot less intimidating than a set of high current jumper leads! It's also safe for EFI equipped cars, whereas jumper leads can cause expensive damage to engine management systems. Fits into a glovebox or under a seat. Operating instructions are included.



**Simply Plugs Into Your Cigarette Lighter Socket. No Greasy Hands or Fiddling About Under the Bonnet in the Dark!**



## CADIK Gas Iron

The advanced CADIK Soldering Iron offers a convenience and a range of functions that redefine the limits of soldering.

**Features:** • See through gas chamber • Built in ignition cap • Uses standard butane gas • Comes with safety bench stand • Supplied with bonus blow torch tip, bench stand and replacement lighter flints. With a sleek, pen like design and self-contained butane power it is easily carried and ready for use anywhere. One single refill of the iron's gas reservoir (from a standard butane refill can) allows up to 60 minutes of continuous use with temperatures ranging from 400°C to 1300°C. A blow torch attachment operates at temperatures in excess of 1300°C which makes it the perfect heat tool for heavy soldering jobs, brazing, silver soldering or heat shrink tubing.

T 2500 **\$39<sup>95</sup>**

## AMAZING BONUS THIS MONTH!

Get a T 2447 Butane Gas Refill and a T 1230 Microwick Twin Pack desoldering braid, valued at **\$11.90 FREE** with every T 2500 CADIK Gas Iron!

## Micron Soldering Station

The MICRON soldering station employs electronic switch mode circuitry in lieu of a mains transformer. Excellent for all general purpose and production soldering.

**Features:** • High insulation ceramic heating element • Rapid heat-up and instant recovery • Heater insulation of over 100MΩ • A zero voltage circuit ensures no high voltage spikes or magnetic field are present at the tip to damage sensitive components • Continuous temperature adjustable from 250° to 430°C (480° to 800°F) • Grounded power cord • Selecting the desired operating temperature is as simple as turning a knob. Now Supplied with Long-Lasting Iron Clad Tip!

T 2443 Normally \$129 This Month **\$99**

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This month only, receive a T 1200 200g Solder roll, AND a T 1230 Microwick Twin Pack desoldering braid, together valued at **\$14.45 FREE** with every T 2443!

## 12" Subwoofer Driver

**Fantastic Hi-Fi Bass on a Budget!**

Specified for the sole purpose of producing denture loosening bass, this 8 ohm, 300mm driver is ideal for subwoofer installations. Rated at a true **100W RMS** continuous, it can handle prodigious amounts of music power! It features a poly emulsion coated cone, which has the lightness of paper with the rigidity of polypropylene, minimising cone flex and distortion with a foam surround, high-efficiency and low-Q. Fantastic addition to a hi-fi or home theatre system to add that extra wallop!

Fo 25Hz, Qts 0.342, Vas 207.8L, Pmax 100 WRMS

C 3100 1997 RRP \$99, NOW **\$79**

## 12V DC - 240VAC 125W Inverter

This incredible little inverter provides up to 125W of 240V power from your car cigarette lighter socket. Features battery status indicator and power on LED, and is fitted with a standard 3-pin socket, so it doesn't need one of those nasty adaptors! We set this unit up on a car battery, and connected it to power our entire A/V room setup, which includes a surround sound amp, VCR, speaker selector unit AND a huge 68cm TV, and cranked up the volume. It ran the lot, and with a perfect TV picture as well! It measures only 125L x 130W x 55H, so it will fit into a glovebox! Perfect for camping, RVs etc. Supplied with cigarette lighter plug input lead.

M 8105 **\$149**

## 9V NiCd Battery Sellout

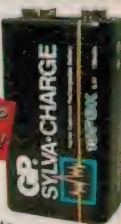
We're clearing out our current stocks of 9V NiCads to make way for our new line! These high quality cells can give hundreds of charge cycles, and will pay for themselves in next to no time. Applications include radios, piezo igniters, kit projects, retic controllers, remote controls and many more! 100mAh current capacity with an 8.4V nominal terminal voltage.

**Note: S 5124 is not available from resellers**

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Simple to connect up and program! Includes comprehensive instructions and programming worksheet!



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## Glass Breakage Detector

Many houses are entered by intruders breaking a window or door pane, and some alarms may not pick them up until they are actually inside the house. This acoustic glass breakage detector responds to the impact on and breakage of glass, and will trigger your security system immediately. One sensor can be used to cover a large area, regardless of the number of windows. It suits Normally Closed circuits and has a NC tamper switch. Sensitivity can be adjusted internally, and three LEDs indicate the activation of air pressure sensor, sound filter and alarm (triggered) output. Suits the S 5350 alarm panel, and many other security systems, too. Powered by 10-16V DC, setup instructions are included.

Features two sensor triggering on air pressure and sound for reliable operation.

S 5365 Glass Breakage Detector **\$39.95**

## Passive Infra Red (PIR) Detector

The S 5315 PIR detector incorporates a pulse count circuit to minimise false triggering, "sense" LED which can be disabled, tamper switch and relay output. Range is up to 12m horizontal when mounted 2m from the floor, with a 90° detection angle. This coverage can be changed by sliding the PCB up or down in its housing. It can be configured as Normally Open or Normally Closed, and has variable sensitivity. It is the ideal sensor for the S 5350 alarm, but it can be used with a wide range of other security systems.

Incorporates Pulse Count Circuitry for Reliable Triggering

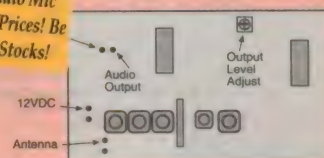
S 5315 PIR Detector **\$49**

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We've bundled up our non-diversity REDBACK radio mic transmitters and receiver modules into complete systems to offer you incredible savings! The receiver module is supplied as a PCB only and requires a power supply, external volume control, antenna etc. Can be built into amplifiers, mixers and DJ consoles. They are professional quality and are used in commercial installations across Australia. They are ideal for DJs, nightclubs, churches, sporting and social clubs, function rooms and community halls. But BE QUICK, we have STRICTLY LIMITED stocks of these systems! Each system includes a receiver module and a hand held microphone transmitter.

C 8150 PCB Receiver Board & Mic Transmitter Systems **\$279** ea

Professional Radio Mic Gear at INSANE Prices! Be Quick, Limited Stocks!



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## Smoke Detector

Fire in homes and business is becoming an increasingly high profile issue these days, and as a result smoke detectors are being installed in many houses across Australia. This detector can be connected to the S 5350's FIRE input, triggering an alarm in the event of a fire, which can not only alert neighbours, but perhaps save lives as well. Powered by 12V DC, and covers up to 70 square meters, depending on room shape. Can be configured to NC or NO output, so it suits the S 5350 and many other systems. An essential component of a comprehensive home security system.

S 5370 Smoke Detector **\$59**

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# 50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Here we feature some items from past issues.

## April 1947

**Modulated Air-Stream:** In a novel PA system developed by the US Army Signal Corps, the conventional loud-speaker is replaced by one in which a jet of air emerging under pressure is modulated by a valve mechanism operating at an audio frequency.

The new equipment has a remarkably low weight-to-output ratio. This is demonstrated by comparison with a typical 300 watt amplifying system. The older equipment weighs about 750 pounds, while the air-stream modulation system weighs only about 80 pounds.

The modulation valve consists of two slotted grids, one of which is the armature and is actuated by a solenoid to produce the variations in air pressure

according to the amplified speech signals. The slots in both grids are .003 inches wide, separated by intervening bars or reeds 0.15 inches wide. When the valve is closed, the reeds in the modulating vane cover the slits in the fixed grid. Used with a conventional loud-speaker horn, sound is projected under normal conditions with a 95% intelligibility or better at distances from two to three miles along the axis.

## April 1972

**Tubeless TV Camera:** A light-sensitive solid state structure capable of storing a pattern of tiny static charges and moving them in sequence at TV speeds has been developed by the RCA Laboratories, Princeton NJ. The sensor, which is a silicon integrated circuit with over 1400

photo-elements in a ladder arrangement, could be the key to the development of a commercial tubeless TV camera.

The prototype is capable of taking a recognisable picture as is, but the number of elements would have to be increased to about 500,000 to reach broadcast picture standards. Light focused on its surface through an ordinary camera lens produces in each element a positive electric charge which varies in direct proportion to the light intensity. The electrical equivalent of the image is stored in the sensor material as a pattern of static point charges. The charges can be 'read out' in sequence and fed to a TV receiver by a unique 'bucket brigade' action in which the discrete charges are passed along from one element to the other.

**Transistors give 140W at 80MHz:** Communications Transistor Corporation, an affiliate of Eimac/Varian, has announced a complement of three rugged communications transistors capable of delivering 140 watts at frequencies up to 80MHz. Operating from 28 volts and covering the frequency range from 30 to 80MHz, the devices come in low inductance stripline packages and are guaranteed to withstand infinite VSWR at all phase angles. ♦

## EA CROSSWORD

### ACROSS

- 1 Alphanumeric memory test with B&W grid. (9,6)
- 8 Plasma containers, magnetic —. (7)
- 10 Solvent. (7)
- 11 Places for small computers? (4)
- 12 Decreases intensity. (5)
- 13 Coated with gold. (4)
- 16 Bring back to original condition. (7)
- 18 Warning: possible shock.(6)

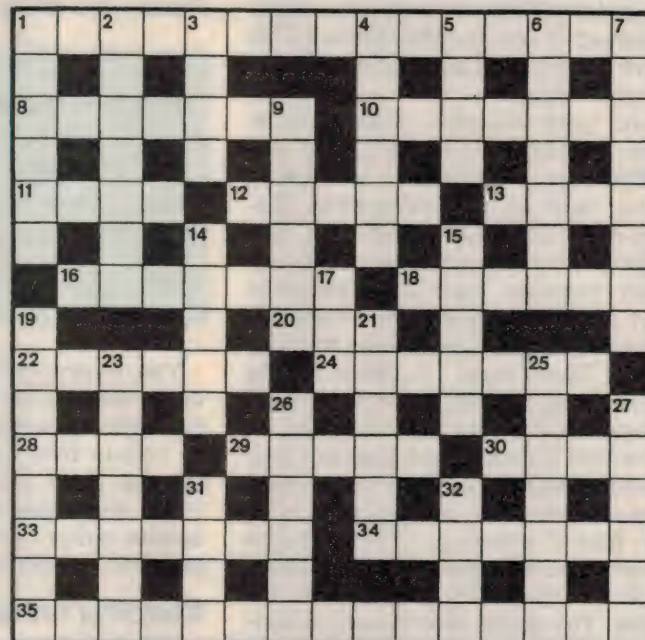
- 20 Total harmonic distortion. (1,1,1)
- 22 Colour in sunlight spectrum. (6)
- 24 Motion of cassette play. (7)
- 28 Type of starter on old two-wheelers. (4)
- 29 Right to a prospecting area. (5)
- 30 Amplification. (4)
- 33 Person gaining experience and qualifications. (7)
- 34 Shaped like a sphere. (7)
- 35 Type of field. (15)

### SOLUTION TO MARCH 1997:

I	N	S	C	R	I	B	E	H	O	O	K	U	P		
M	P	E	A	T	L	N	E								
P	R	E	T	E	S	T	H	A	R	P	O	O	N		
A	A	F	T	E	T	W	U								
T	A	K	E	H	E	N	R	I	F	A	R	M			
T	E	F	R	M	K	L	B								
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A	Z	I	M	U	T	H		R	E	C	O	R	D		
K	O	S		A	U	K	O								
E	O	N	S		P	R	I	N	T	Y	A	G	I		
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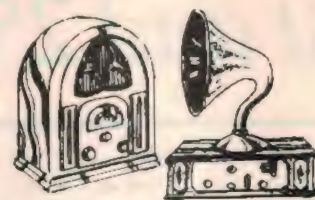
### DOWN

- 1 Magnetic metal. (6)
- 2 Group of eight. (7)
- 3 Crystalline substance. (4)
- 4 Reduce intensity; muffle.(6)
- 5 Put into service. (4)
- 6 Changing focal length. (7)
- 7 Permanently polarised material. (8)
- 9 Application of ink by a printer. (6)
- 14 Section of an amplifying system. (5)
- 15 Watches TV, etc. (5)



- 17 Extremely high frequency. (1,1,1)
- 19 Item that stores data. (8)
- 21 The addition of traces of impurities. (6)
- 23 Speak to a recorder. (7)
- 25 Display of data. (7)
- 26 Measure of surface reflectivity of a planet. (6)
- 27 Pertaining to a positive pole. (6)
- 31 Quantity taken as standard of measurement. (4)
- 32 Part of a speaker. (4) ♦





## The value of vintage sets & components

This month I'm tackling a couple of topics with the intention of helping newer enthusiasts. One is how you judge the original prices of sets and components made long before Australia changed to decimal currency — were they cheap, or expensive? The other is valves: how to understand them, how to acquire them, sort and identify them.

Peter Lankshear, the late Neville Williams and other writers on vintage topics have sometimes alluded to the original price of equipment and components — which was the price of the item at that time in history. But quoting past prices and trying to relate them to today's values is a different matter.

Prior to decimal currency, Australia's currency was based on 'Sterling' the English currency, but ours had a different value from that of the UK. The elements of Sterling were pounds, shillings and pence, abbreviated as '£', 's' and 'd' respectively. (Why the letter 'd' to signify pence? It was an abbreviation of the Latin *denarius*, an ancient Roman coin of small value.)

The most common denominations were £10, £5 and £1 notes, and a 10-shilling note. The nickname for a pound was a 'quid' or, in rhyming slang, 'fiddle-did'. The silver coins were two shillings (two bob), a shilling (a bob or a dina), sixpence (zac) and threepence (treyp bit); the copper coins ('coppers') were pennies and half-pennies (ha'pennies). There were 12 pence to the shilling, and 20 shillings to the pound. The pound, therefore, was 240 pence.

On 14th February 1966, Australia converted to decimal currency. The conversion eliminated the middle category of the former currency. Twelve pence became 10 cents, and one hundred cents, or the old 10-shilling note, became one dollar. The pound note became a two-dollar note. The fractional parts of the old shilling were converted accordingly to the nearest value of decimal coinage. Hence a five cent piece was equivalent to the old sixpence.

Why this lesson in numismatics? It is to relate to values, and hence purchasing power, rather than just comparing the prices of the 1920s, 1930s and

1940s to today's prices — when to the uninitiated they seem absurdly low.

### Average earnings

Most readers will have heard the term 'average male weekly earnings'. The most current figure is now \$693.00 per week, not including overtime (why is it that I'm missing out?). Does such a figure exist for past years? The answer is yes, of course, and examples of weekly wages are tabulated in Table 1 by courtesy of the National Institute of Labour Studies, Flinders University, Adelaide.

**TABLE 1: Weekly Earnings**

Year	Weighted Average	Engineering Industries	Women
1925	\$9.47	\$9.70	\$4.97
1935	\$8.22	\$8.38	\$4.35
1948	\$14.62	\$14.99	\$9.38

Yes, wages went down in the early 1930s because the Government of the day reduced wages across the board by 10% to 20%, as a measure to combat the great depression. By about 1936, they were back to levels of a decade earlier. 1948 is an example of post war prosperity.

### Keeping things relative

We can now see that a radio set advertised complete with valves, speaker and batteries, for £28 (which converts directly to \$56) in 1925, represents about six weeks' wages — or, by comparison, \$4100 in today's money! So in reality those early sets were incredibly *expensive*, when we consider what they were. Think of what \$4000-odd will buy today

in the way of electronics and home entertainment!

Radios of the 1930s were not only cheaper in comparison to the 1920s, but you got far more for your money.

So when prices are seen or quoted from yesteryear, keep in mind the conversion factors, and also relate the prices quoted in terms of weekly earnings at the time. Only then can the relative cost can be seen in a valid and realistic way.

### Finding valves

The newcomer to vintage radio is often concerned about the availability of valves. Valves can usually be obtained via auction sales, swap meets and advertisements conducted by the Wireless Institute of Australia or the Historical Radio Society of Australia for the benefit of members. Equivalent overseas societies no doubt hold similar sales.

The valves can often be purchased by the sugarbag or shoe carton, for sometimes very modest amounts. But the catch is that valves purchased in this way are sight unseen, or pot luck. They may well not be worth even the modest sum you pay for them.

It's important to know more about valves, in order to be able to make more informed decisions and purchases.

Let's look first at valve numbering systems. What do those numbers mean? Can you tell what a valve is by the number? A leprechaun might well answer "Well now, it 'tis and it 'tisn't!"

With any luck, the number will be intact somewhere on the glass envelope, usually about half way down from the shoulder to the base. If it not easily visible, it needs to be identified.

**By the way, resist all temptation to clean the valve with detergent and a cloth or paper towel. This can**



**remove all trace of the original identification markings!**

To identify the older style valves with very faint numbers you often need a cool morning and a bottle of methylated spirit-based glass cleaner such as 'Windex'. Spray a fine mist of the glass cleaner around the valve and then breathe on it. The combination of cold glass, hot moist breath and the glass cleaner will make the number momentarily appear! If at first you don't succeed, try again on a different part of the envelope. Having identified it, I write the number on the base with a felt tipped pen.

## The American system

The very early American made valves had a numbering system that composed of firstly, two letters which were either 'UV', 'UX' or 'UY', followed by three digits. The letters defined the base. UV was for the small four-pin base, UX the standard four-pin base like that used for the type 80 rectifier, and UY is for the standard five-pin base.

The first of the three digits identified the manufacturer. For example, '2' was for RCA made valves and '3' was for valves made by Cunningham. The second and third digits actually defined the valve itself!

Eventually, in about 1933, all of the preamble was scrapped from the numbering system such that only the last two digits appeared as the type. For example, what had been a 'UY 235' merely became a type '35', and a '327' became a type '27' and so on.

With the later, i.e., post-1934 'American' system, the first figure indicates the heater or filament voltage. So '1' is for 1.4 volt or 2.0 volt battery valves, '2' is for 2.5 volt AC types, '6' is for 6.3V AC types and so on. The second identifier is a characteristic letter (i.e., the particular type), and the last identifier refers to the number of elements within the valve. The heater is considered as one element only, with the cathode regarded as a separate element. With octal based glass valves, the last letter(s) 'G' or 'GT' refer to the size of the bulb.

However, as more valves were released, there were many exceptions to the rule, and the American system gives absolutely no indication of the type of valve or the use to which it may be put.

## The European system

The European, or sometimes called 'Philips' system, is more organised. The first letter indicates the filament/heater voltage, the next one or two characteris-



**Three relatively early American valves. On the right is a type 30 battery triode with a 'UX' type four-pin base, while in the centre is a type 24A indirectly heated 2.5V RF tetrode and at left a type 47 directly heated 2.5V output pentode — both using the 'G' envelope with a five-pin base.**

tic letter identifiers define the actual type of valve that it is, the next one or two numbers determine the construction and base, and also the variant of the valve type, as defined by the identifying letters. This nomenclature was for valves from 1935 onwards.

The early European system was different again. Many enthusiasts are familiar with the Philips four-pin triodes, such as A 415. Here the letter indicated the filament current. The last two digits indicated the amplification factor in the case of a triode, and the first, (or in the case of a four-digit number, the first two, digits) indicated the filament voltage. Hence, an A 415 is a 4.0 volt type with an amplification factor of 15.

In the case of a multigrid type, the last two figures indicated the classification. This numbering system held good for many of the Philips 'gold series' valves, and the identifying numbers and letters are tabulated elsewhere.

In the pre-war years, there were a plethora of British valve manufacturers — all of whom had a particular numbering system devoid of both rhyme and reason. Indeed, there are cases where a valve might have been given the same number by two different manufacturers, and the valves are totally different!

In order to become familiar with a valve, and to be able to test it and to determine if it is working within speci-

fication, you will need to know something about how a valve works, and also the characteristic data.

The *Philips Miniwatt Technical Data book* (7th edition) — often called the 'Philips valve data book' — or the *RCA Receiving Tube Manual* are both very good reference books. Both books, where applicable, give direct equivalents to different versions of the same valve (yet another story in itself!).

## Characteristic curves

The RCA manual has the distinct advantage that it publishes characteristic curves for the types currently in production as at the time of printing, but is limited to valves made only by the RCA company. The best versions to get for the RCA manual are around about editions 14 - 18. The RCA manual also has an excellent technical section explaining what characteristics and their curves mean, and how to use and interpret the information.

The 'Philips' data book has, with consent, been re-printed and is available to members of the Historical Radio Society of Australia. The RCA book can sometimes be obtained at swapmeets and the like. Of the two books, the RCA manual contains more information about a given valve, but it is harder to acquire.

There are other books which will become known to the newcomer as he



or she progresses with their hobby. Some of the references are quite specialised, are scarce and sought after, such as Babini's *International Radio Tube Encyclopedia*.

A very good source of general information on valve operation and applications is of course the famous AWW *Radiotron Designers Handbook* edited by Fritz Langford-Smith, especially the 4th edition of 1952 (reprinted many times until at least 1963).

## Equivalent types

Some valves were produced with a different filament voltage and/or a different base. It is beyond the scope of this article to tabulate or give by way of example what valves had octal-based equivalents and what valves did not. The valve data books contain all that information, and many old hands have also committed it to memory.

Fortunately, most of the radios and equipment produced in this country used valves with either the American pre-octal bases or octal bases. Reference was made earlier to 'Philips four-pin triodes'. Valves with the 'Philips' label were made for export only, and the triodes and other valves of the early 1930's mainly had American, and not European type bases.

European bases were generally asymmetric arrangements of common diameter pins, and look quite different to the American bases. They are easily recognisable.

## Summary

In summary, the newcomer is most likely to find fairly easily the valves that conform to, and were used by the radios that were made in Australia. That is, pre-octal and octal valves of the common varieties, both 'European' and 'American' types. The foregoing is but one paragraph of the introductory chapter of the story of valves, and includes generalisations for which no apology is offered.

Testing, repairing and determining substitutes for hard to get types will be the subject of future articles and will require a little understanding and knowledge of valves on the part of the reader. No mention of British manufacturers, valves with British bases and military valves has been made, and these will have to wait for another time. ♦

### TABLE 2: European Valve Nomenclature

#### 1. Early System (Prior to 1934)

<b>Letter:</b>	A Filament current of 60 - 100mA
	C Filament current of 200 - 400mA
	D Filament current of 400 - 700mA
	E Filament current of 700 - 1250mA
	F Filament current of 1.25A and over
	Filament or heater voltage (nominal)
<b>1st Figure or 1st &amp; 2nd Figures:</b>	
<b>2nd &amp; 3rd Figures or 3rd &amp; 4th Figures:</b>	(i) For triode valves, amplification factor for published operating conditions
	(ii) For multi-grid valves —
	41, 51, 61, etc.: Tetrodes with space charge grid
	42, 52, 62, etc.: Radio frequency tetrodes
	43, 53, 63, etc.: Output pentodes
	44, 54, 64, etc.: Diode triodes, diode tetrodes
	45, 55, 65, etc.: Remote cutoff RF tetrodes
	46, 56, 66, etc.: RF pentodes
	47, 57, 67, etc.: Remote cutoff RF pentodes
	48, 58, 68, etc.: Hexode mixers
	49, 59, 69, etc.: Remote cutoff hexode mixers

#### 2. Later System (after 1934)

The later system used a number of capital letters followed by either one or two figures (e.g., EBC3, EL33). The first letter indicates the filament or heater rating, whilst the remaining letters give the type classification. The figures indicate both individual type identification and the valve base and/or type valve construction used. In some cases a letter suffix is used to indicate a minor constructional or characteristic change (e.g. EL33 - EL33A). The key to this system is given below:

<b>1st Letter (Filament/Heater Ratings)</b>	A 4V AC type
	B 180mA DC type
	C 200mA AC/DC type
	D Battery types up to 1.4V DC
	E 6.3V AC type
	F 13V car radio type
	G 5V AC type
	K 2V battery type
	P 300mA AC/DC type
	U 100mA AC/DC type
	V 50mA AC/DC type
<b>2nd &amp; Subsequent Letters (Type Classification)</b>	A Single diode
	B Double diode
	C Triodes, except output triodes
	D Output triode
	E Tetrode
	F Pentodes, except output pentodes
	H Hexode or heptode
	K Octode
	L Output pentode
	M Tuning indicator
	P Secondary emission valve
	W Half wave gas-filled rectifier
	X Full wave gas-filled rectifier
	Y Half wave high-vacuum rectifier
	Z Full wave high-vacuum rectifier

<b>Number Sequence</b>	1-10 Pinch type construction valves fitted with European 5-pin (V base) or 8-pin (P base) side contact bases, or international octal bases with European basing connection sequence.
	11-19 European type metal valves and glass valves fitted with European metal bases.
	20-29 All-glass valves fitted with 8-pin Loktal type American bases.
	30-39 Pinch type construction valves fitted with international octal bases with American basing connection sequence.
	40-49 All-glass miniature valves fitted with 8-pin Rimlock base.
	50-59 Special construction types fitted with bases applicable to design features used.
	60-61 All-glass valves fitted with 9-pin base.
	65-79 Sub-miniature all-glass valves with or without bases.
	80-89 All-glass miniature valves fitted with 9-pin American 'Novel' type base.
	90-99 All-glass miniature valves fitted with 7-pin American 'Button' type base.

#### Exceptions to the above

- (a) DAC21, DF21, DF22, DK21, DL21, DLL21 were of pinch type construction fitted with international octal bases with European base connection sequence.
- (b) ECH3G, ECH4G, EK2G, EK2G/GT, EL3G, EL3NG, KF3G, KK2G, KL4G were of pinch type construction fitted with international octal bases with American base connection sequence.
- (c) KK2 (Cap E) was of pinch-type construction fitted with a medium 7-pin American base.
- (d) EBF2G, EBF2GT/G, EBF35 were of pinch-type construction fitted with international octal bases with European base connection sequence.



Electronics Australia's

# Professional Electronics

S ♦ U ♦ P ♦ P ♦ L ♦ E ♦ M ♦ E ♦ N ♦ T

**TOSHIBA DEVELOPS CMOS  
IMAGE SENSOR FOR NEXT  
GENERATION OF DIGITAL  
CAMERAS & CAMCORDERS**

**LOCAL FIRM DEVELOPS  
'INTELLIGENT' KEYBOARD  
FOR CCTV SYSTEM CONTROL**

**TECHNOLOGY BACKGROUNDER:  
WHAT'S BEHIND MPEG  
DIGITAL VIDEO COMPRESSION**

**THE NEW FIELDWORKS  
FW5000 RUGGEDISED  
MIL-SPEC NOTEBOOK  
PC FROM RACAL, FOR  
POLICE & MILITARY:  
INTERNAL COOLING  
PLUS ONE-PIECE  
MAGNESIUM ALLOY  
CHASSIS WITH RUBBER  
INSULATION — GIVING  
THE ABILITY TO  
WITHSTAND OPERATING  
SHOCKS OF UP TO 100G!**

*(See Computer News)*





# NEWS HIGHLIGHTS

## ABA RELEASES DIGITAL TV REPORT

Twenty-first century television will deliver wide-screen, high definition pictures and high quality multi-channel sound, according to a report on Digital Terrestrial TV Broadcasting released by the Australian Broadcasting Authority (ABA).

"Digital technology will result in fundamental changes to broadcast television," said Mr Peter Webb, ABA Chairman. "The new systems provide incredible flexibility and scope for further enhancement and should provide the perfect vehicle upon which television will be built for the next 50 years."

Digital television is now being adopted world-wide as the future approach to television delivery, and is expected to be introduced progressively from around the turn of the century. It opens the way to full integration of satellite, cable and terrestrial television and creates new and exciting possibilities for program producers.

The ABA's report, *Digital Terrestrial Television Broadcasting in Australia*, was prepared by the Digital Terrestrial Television Specialist Group of the ABA. The report sets out recommenda-

tions on the way in which digital television might be introduced into Australia.

"International standards for this future television system have just been completed and the time is right for Australia to start planning for the changes", said Mr Webb.

Digital television will need to coexist with the present analog system for something like 15 to 20 years, allowing viewers to move up to digital at their own pace when they need to replace their existing analog receivers. It will take several years to establish the new digital transmitters and studio facilities, but consumer receivers are expected to become available overseas as early as 1998.

Copies of the report are available from the ABA, price \$10, by phoning them on (02) 9334 7700.

## IMPROVED MARINE SAFETY VIA INMARSAT

A faster, more reliable and accurate satellite distress alerting system for sailors has been inaugurated by Inmarsat, the London-based international mobile communications satellite operator. Use of the system — a joint development of the German

Government, the European Space Agency, Nortel-Dasa, Siemens, Nokia, MBB and Inmarsat — will be free of charge to customers.

The new system covers virtually all of the world's ocean areas and is fully compliant with the Global Maritime Distress and Safety System (GMDSS).

"The inauguration of the Inmarsat-E system reaffirms Inmarsat's commitment to the development and use of the latest and best satellite technology for safety, and the preservation of life at sea," said Inmarsat Director General Warren Grace.

In a recent series of tests, Inmarsat-E proved to be 100% reliable in delivering a comprehensive distress message to Inmarsat-E Land Earth Stations (LESS), typically within two minutes of an initial alert.

## TOSHIBA DEVELOPS CMOS IMAGE SENSOR

Toshiba Corporation in Japan has announced a 330,000 pixel complementary metal oxide semiconductor (CMOS) 1/4" image sensor which offers a level of performance sufficient for use in digital still cameras. The prototype sensor was fabricated using the CMOS process, the most widely used semiconductor processing technology, and one which has the potential to realize significant structural and functional advantages over CCD image sensors, the standard imaging device for today's digital cameras.

The prototype CMOS sensor operates with single 5V power supply. It consumes only 30mW, approximately 1/10 of the power of a CCD.

The potential advantages of CMOS are attracting widespread industry attention as an alternative to CCDs in image sensors. In this emerging area, Toshiba's prototype image sensor represents a major breakthrough, in achieving CMOS pixel cells small enough for application in commercial products.

Toshiba has optimized the pixel cell circuit structure to shrink its size and achieve new levels of integration. Each pixel cell, with such basic elements as photodiodes and transistors, is packed into 5.6 x 5.6 square microns — approximately 30% smaller than other CMOS



*Designed by Professor Gunter Rochelt, Stuttgart University's solar-powered aircraft ICARE 2 has a wing-span of 25 metres and uses 2500 solar cells for propulsion power. It has been cleared for all-weather operation, and has a maximum speed of 120km/h. (IN-Press/dpa)*



pixel cells already announced. The new prototype sensor was fabricated using 0.6µm design rule CMOS technology. It is designed to support the 640 x 480 pixel VGA format, and is suitable for application in products.

## KODAK EXPANDS CD-R PRODUCTION

Eastman Kodak has strengthened its claimed position as the world's largest producer of CD-Recordable media with the official opening of a new disc production facility in Ireland's Youghal, County Cork.

Australian demand for CD-Rs is 'going through the roof' according to Kodak Product Manager Rowan Lawson. Disc volume appears to be driven by the worldwide increase of 332% in writer sales during 1996. "The real growth is due to the drop in price of writers, yet while prices declined, software and other components of the bundle were enhanced, offering better value to the end user," Lawson said.

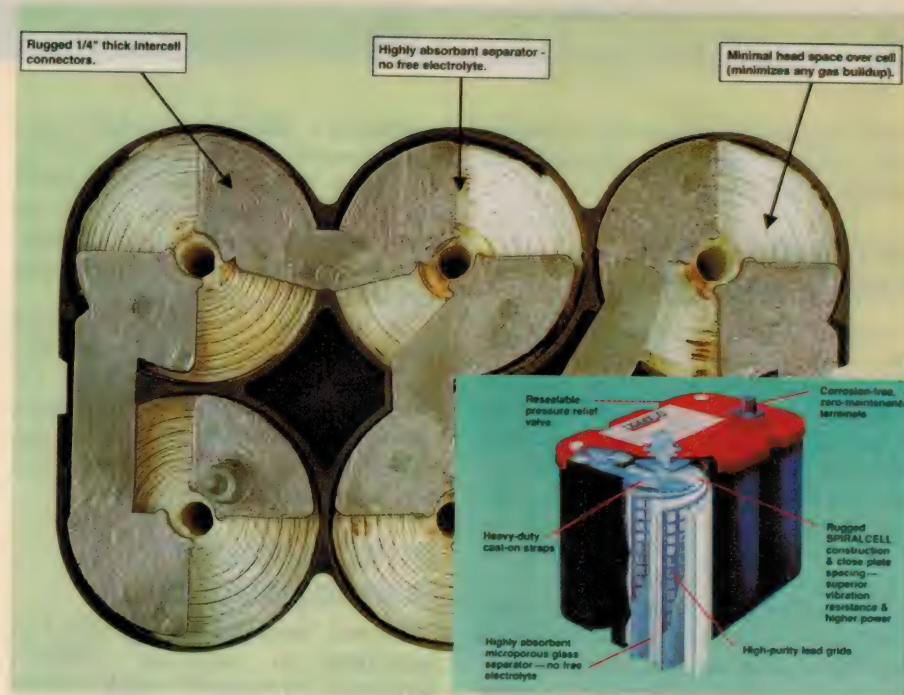
The new facility will help meet the rapidly growing demand for what Kodak calls 'Writable CD' discs, which store 680MB or 420,000 pages of text. Digital content can include databases, document images, pictorial images, software, motion video, and audio.

The company simultaneously announced plans to expand its disc production facilities in Guadalajara, Mexico. In addition, Kodak manufactures discs in Rochester, NY and has custom screen printing and packaging facilities in Harrow, United Kingdom. With these worldwide expansion plans, the company said, Kodak's investments will exceed A\$180M. "When our current expansion plans are complete, we project that our manufacturing capacity will reach 18 million discs per month by the end of 1998," Lawson said.

## ZATEK APPOINTED AMD DISTRIBUTOR

AMD has appointed Zatek Australia Pty Ltd, (an Arrow Electronics, Inc. company), as distributor of its semiconductor and other product lines in Australia. The appointment is part of an aggressive move by AMD to enhance its presence in Australia and increase market share.

"As the desktop market continues to dramatically evolve, AMD faces new and greater opportunities", said Jerry Lynch, vice president of AMD's sales and marketing in Asia Pacific. "Zatek



*A few months ago we carried an item about the new Optima lead-acid batteries, with 'SpiralCell' technology. Here are some further pictures which reveal their novel internal construction. The importers are Optima Batteries (Aust), 441 Station Street, Box Hill 3128; phone (03) 9897 3999.*

has the local knowledge and specialist expertise to help grow AMD's business effectively in Australia."

Zatek will be distributing AMD's microprocessors; Flash, EPROM, BiPolar PROMs and FIFO memory products; AMD SLIC/SLAC line card communications products; Taxi network chips; and 8-, 16- and 32-bit embedded processors.

## SCAN AUDIO DIST'G RUNCO TV PROJECTORS

Melbourne firm Scan Audio has been appointed sole Australian distributor for RUNCO high quality video projectors.

RUNCO claims to be the leading 'home cinema' video projector manufacturer in America. The brand boasts many awards for both excellence in picture quality, and innovation.

Runco produces a wide range of 'three tube' projectors, extending up to state-of-art broad bandwidth data models. They also have two data-grade liquid crystal (LCD) projectors in the single lens configuration. And to complete the line-up, RUNCO also has a projector featuring the new Digital Light Processing technology from Texas Instruments.

Rounding off Runco's range of high performance products is a line doubler, a line quadrupler and a high quality laserdisc player.

## NATA CELEBRATING 50TH ANNIVERSARY

The National Association of Testing Authorities is celebrating its 50th anniversary this year, marking one of the great self-help stories of Australia's industrial history — a story which continues today with new initiatives in laboratory accreditation and quality and environmental certification programmes.

NATA was born in 1947 as the first national laboratory accreditation system in the world, after Ben Chifley's government recognised the importance of fostering the technical and scientific infrastructure vital for Australia to move from dependence on primary production to serious industrial development.

"Before industry could start turning out world-class goods and services, it had to have a sound national measurement system in place as a cornerstone for the evaluation of materials, products and equipment", said the Chief Executive of NATA, Mr John Gilmour. "Testing and measurement laboratories were central to this process. No matter what the industry, it was the laboratories that were responsible for monitoring the standards for just about everything of significance produced by this country."

Since its inception, NATA has accredited more than 3500 laboratories,



becoming the largest and most diversified national laboratory accreditation system in the world.

### OPTUS TO PROVIDE AARNET ATM NETWORK

Optus Networks has been chosen to provide a new ATM (asynchronous transfer mode) based private national integrated backbone for AARNet — the Australian Academic and Research Network. The network will exploit the multimedia capacity of ATM by allowing broadband applications such as video conferencing and tele-teaching, as well as providing Internet access.

Optus won the contract after a comprehensive selection process conducted by the Australian Vice-Chancellors' Committee (AVCC). The AVCC established the AARNet in 1990 to link universities and research institutions electronically. Currently there are 37 Australian universities and all the divisions of CSIRO who use the AARNet for Internet access.

The fully integrated network will provide high speed dedicated links between each of the regional network operations (RNOs) in NSW, Victoria, Queensland, South Australia, Western Australia, Tasmania and the Northern Territory. Optus is investing \$50 million in ATM technology, as well as \$70 million in a new data centre in northern Sydney.

### INMARSAT-3 F3 ENTERS SERVICE

Personal mobile satellite phone services are now available for all those who do business, live or venture off the beaten track in the Pacific Ocean region. The third satellite in the Inmarsat-3 series, claimed as the world's most advanced communications spacecraft, entered service on Saturday, January 25 at 17.00 GMT.

Inmarsat-3 F3 joins two other similar satellites already in operation, extending to about 95% of the world's land mass the benefit of the new personal Inmarsatphone service. The spacecraft also boosts capacity for Inmarsat's other commercial maritime, aeronautical and land-mobile communications systems.

Inmarsat's third generation will eventually comprise five satellites. The final two in the constellation are planned to lift-off this year on Ariane IV rockets from Kourou, French Guiana.

Inmarsat-3 satellites are eight times more powerful than Inmarsat-2 and feature spot beam technology, which enables them to focus this power on areas where traffic demand is greatest. This satellite power allows the operation of small, light satellite phones.

The Inmarsat-3 F3 satellite, launched aboard an Atlas IIA rocket from Cape Canaveral, Florida, on December 18, has taken over traffic from Inmarsat's previous generation Pacific Ocean region satellite, Inmarsat-2 F3, which now becomes a system backup.

### NATIONAL SELLING FAIRCHILD BUSINESS

National Semiconductor has signed an agreement to sell its Fairchild Semiconductor business, which consists of a broad portfolio of logic, discrete and non-volatile memory semiconductor devices aimed at high volume markets.

The agreement calls for Fairchild Semiconductor's management and Sterling LLC, a Citicorp Venture Capital investment portfolio company, to lead a US\$550-million recapitalization of Fairchild Semiconductor. National Semiconductor will retain a minority equity interest in Fairchild.

Brian L. Haila, president and CEO of National Semiconductor, said, "This sale enables each company to concentrate on its core competencies to maximize their businesses, which operate with very different strategies and success models. National can now focus more closely on delivering highly integrated systems solutions based on our analog and mixed signal expertise addressing solutions for the information superhighway, communications, consumer and personal systems marketplace."

After the sale is completed National will have 12,300 employees and Fairchild will have 6400. National will continue to operate wafer fabrication facilities at Santa Clara, California; Arlington, Texas; and Greenock, Scotland; as well as the new 8"/0.35um wafer lab at South Portland, Maine. National will also operate test and assembly sites in Singapore and Melaka, Malaysia.

Fairchild Semiconductor will be headquartered in South Portland, Maine, with its memory and discrete product groups located in Santa Clara, California. Fairchild will operate 4", 5" and 6" wafer fabs in South Portland and a 6" fab in West Jordan, Utah.



**US chip testing firm Sonoscan has just released FACTS2, a high speed acoustic testing system capable of automatically screening ICs in plastic packages for internal defects at up to one device per second, and providing accept/reject data as well at rates of up to 20,000 devices per 8-hour shift.**



## INTELLIGENT CCTV KEYBOARD LAUNCHED

Pacific Communications Group, an Australian supplier of innovative CCTV systems, has launched what it claims as the most revolutionary CCTV control keyboard ever developed.

The Pacom 2035 Intelligent Keyboard incorporates for the first time a passive backlit LCD panel which allows users to be guided by 'plain English' text and icons, so they can know exactly what is happening at all times.

Designed in Australia by Pacific's R&D department, following an intensive review of customer requirements, the keyboard is designed to be used intuitively — so that time on the job can be dedicated to actual surveillance rather than 'figuring out what to do next'.

The 2035 includes several advanced features, including 'intelligent' diagnostics, a menu and 'soft key' system to prevent information overload, and variable speed proportional joystick control. Another important feature is the ability to emulate the familiar icon functions of a VCR or digital recorder.

The new keyboard is also provided with a replaceable decal to allow customising the soft key user buttons.

Pacific's CCTV systems and products are being used by leading retail groups, law enforcement agencies, financial



institutions, factories and industrial sites, sports venues, hotels and casinos.

## MAKING CLEAN ROOMS MORE ENERGY EFFICIENT

A study by three investigators at the Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab) in California has suggested methods of reducing energy consumption by the 'clean rooms' required for such activities as semiconductor manufacture. The study was part of an ongoing effort at Berkeley Lab to develop energy-efficient design and operational practices for cleanrooms.

"Cleanrooms are used extensively in high technology industries and research laboratories," said David Faulkner of Berkeley Lab's Energy & Environment Division. "These facilities maintain low particle concentrations by circulating the entire volume of air in the lab at a high rate, often 400 to 600 times per hour through high efficiency particulate air filters (HEPA). In the typical cleanroom, air flows through the space at 60 to 100 feet per minute, and the fans are never turned off. Most clean rooms run 24 hours a day, seven days a week," said Faulkner.

According to Faulkner, "Common

industry practice is to keep the fans on even when the cleanroom is not being used, because it is thought that if they're turned off, or if the fan speeds are changed, it will take hours to restore the room to the required specification."

To test this belief and determine whether an alternative airflow environment could maintain particle concentrations at nominal levels, Faulkner and William Fisk of the Indoor Environment Program, and John Walton of Berkeley Lab's Engineering Division developed a scheme called demand-control filtration (DCF). Using a 300-square-foot cleanroom dedicated to experimental work, they set up a commercially available particle counter near a manufacturing station, and devised a system to feed the particle count back to an automatic control system that regulated the speed of the fan serving the room.

The researchers first ran measurements of particle concentration under the facility's normal operating environment — fans running at high speed for 12 hours a day, and at a slightly lower speed during the night when the facility was not in use. Then they ran the fan under two other automatic control schemes.

In the first scheme, the counter measured particle concentration each second. At any time, if the count exceeded the maximum allowable concentration, the fan speed increased 10%. If the count was below the allowable limit, the fan speed decreased by 0.1%. This scheme increased the fan speed quickly, and decreased it slowly.

In the second scheme, the fan speed increased in proportion to how many particles were in the air if the particle count was above the allowable threshold. Thus, if the counter detected substantially more than 100 particles per cubic foot, the control system increased fan speed by up to 70%; if the counter measured a slight increase in particles, the fan speed increased, but only up to about 10% of its original speed.

"Two results stand out," says Faulkner. "The first is that both methods saved energy — 60% of the fan energy used in the pre-existing control method, in which a variable-speed drive reduced fan speed at night. A more common situation is when the motors in a control scheme don't have variable speed drives. In this case, both of our methods would have saved 84% of the baseline energy. Both methods showed about the same energy savings."

"Second, when we increased and decreased the fan speed in the unoccupied cleanroom by 10% or more, we did not see any sudden increases in particle concentration from the shedding of particles by the filters," he adds. This result suggests that managers of cleanroom facilities do not need to keep fans on their highest speed all the time to keep the air at the required level of purity. ♦

## NEWS BRIEFS

- Hitachi Sales Australia has merged with **Hitachi Australia**, and is now located at 13-15 Lyonpark Road, North Ryde 2113; phone (02) 9888 4188.
- **Wandel and Golterman** has appointed Steve Smith to the position of Australian National Manager, Networking Products.
- The 14th Australian telecommunication and data networking exhibition and conference **ATUG '97** will be held at the Darling Harbour Exhibition Centre from 13 to 15 May 1997.
- Papers are now being called for **APCC '97**, the 3rd Asia-Pacific Conference on Communication to be held in Sydney, 7-10 December 1997. For more information contact IREE Society (02) 9929 0099.
- **Advanced Micro Devices** has announced the appointment of Stephen Tsang as director of sales for Southeast Asia. ♦



# NEW PRODUCTS

## DVM displays two measurements

Escort's new model 97 digital multi-meter features an extended range of measurement capabilities that include frequency, conductance, duty cycle, capacitance and dBm, as well as the usual AC/DC voltage and current, and resistance. Another feature is a pulse output with timer function that provides either a low/high or a high/low timer in one second steps up to 99,999 steps. Also provided is a square wave output with adjustable duty cycle from 0.5Hz to 4.8kHz.

The meter has a selectable backlit display with two 40,000 count digital readouts, plus an analog bargraph. This allows two measurements of the same signal, such as frequency and dBm. The instrument has true RMS + DC measurement for voltage and current and can measure frequencies to 10MHz, with an accuracy of 0.002% of the reading. Other features include temperature measurement from -40 to +1372°C using an optionally available type K probe, and an RS-232 communications port to download data to a PC or printer using an optional communications package that includes software. The meter is designed to safety class IEC-1010-1, 600V cat III and 1000V cat II. The RRP



is \$499 (ex tax).

For further information circle 241 on the reader service coupon or contact Emona Instruments, PO Box 15, Camperdown 2050; phone (02) 9519 3933.

## IC lead former

The Formit ICF-100 high speed IC forming machine is claimed to substantially improve productivity in electronics manufacture, by automatically forming the legs of integrated circuits before they are assembled onto a printed circuit board. ICs are usually manufactured with their legs splayed out, which means they have to be squeezed together before being inserted into a board or socket. This is usually done with a hand roller set to the various IC pitches.

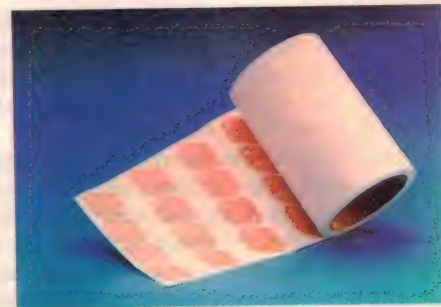
The ICF-100 motorises this operation. In three seconds it will take the contents of a standard IC tube, form the legs ready for insertion and feed them into a second tube. The operator then sets the first tube to receive the next batch of ICs and the process continues.

The IC width is continuously adjustable between 7.62mm (0.3") and 15.24mm (0.6") pitch by a control knob. This avoids the need to dismantle the machine and re-assemble it with a new feeding rail of the required pitch, as in earlier models.

For further information circle 242 on the reader service coupon or contact Computronics International, PO Box 8076, Perth Business Centre, Perth 6849; phone (09) 221 2121.

## Thermal material for power electronics

Orcus has announced Thermaphase, a new type of thermal interface material for power semiconductors, microprocessors and other power electronics. The new phase-change material is solid at room temperature. At a temperature slightly above normal semiconductor operating temperatures, the material changes to a liquid and flows into the microscopic voids of both semiconductor and heatsink, to provide 100% thermal contact. The resulting decrease in thermal resistance cools the semiconductor to a temperature below the phase-



change temperature of the compound, so it reverts to being a solid.

The material is available in two versions: electrically insulating and electrically conductive. The thermal resistance of the electrically insulating version can be as low as 0.17°C/W. The electrically conductive type has a thermal resistance of 0.025°C/W.

The new material has several advantages over other solid style thermal interface materials, including a lower mounting force and better chemical resistance. It also eliminates cold flow of elastomeric materials and the need for thermal grease. The product comes on adhesive backing paper.

For further information contact Manford Eaton, Orcus Inc, Box 307, Stilwell, Kansas 66085 USA; phone (913) 768 1875, or email them at [orcusnet@tyrell.net](mailto:orcusnet@tyrell.net).

## GPS Rx has digital chartplotter

Garmin has announced the GPSMAP 175, a combined GPS and digital chartplotter in a handheld instrument. The unit is claimed to offer all the features of larger, fixed mounting GPS/chartplotters, and features a parallel channel receiver for quick, accurate GPS position data. The instrument comes with a worldwide basemap detailed to 64 nautical miles, although when used with Garmin's G-chart cartridges, it can provide on-screen detail to 0.125 nautical miles.

Features of the unit include a 104mm (4.1") EL backlit display with four levels of grey scale (38,400 pixels), 3D graphic highway steering guidance, fuel and trip planning, on-screen point-to-point distance and bearing calculations. It also has moving map plotting with pushbut-





ton zoom and panning capabilities; audible arrival, crosstalk, clock timer and anchor alarms. Included are 250 alphanumeric waypoints with 20 reversible routes. It has a 10 hour battery life from six AA alkaline cells and comes with an alkaline battery pack, carrying case, wrist strap, manual and quick reference card.

For further information circle 244 on the reader service coupon or contact Standard Communications, PO Box 296, Gladesville 2111; phone (02) 9844 6666.

## 20MHz oscilloscope has signal output

Leader Instruments has released a new 20MHz oscilloscope priced under \$800 (including tax). The LS1020 dual trace oscilloscope features a maximum sensitivity of 500uV/div and a maximum sweep speed of 50ns/div. Channel 1 of the instrument has a buffered wideband amplifier output for connection to another instrument such as a frequency counter, to make simultaneous measure-

ments of the input signal.

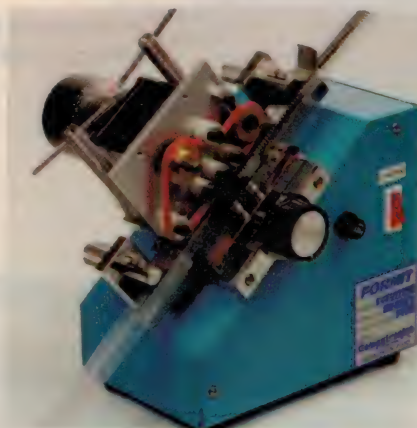
Another feature is the variable hold-off function, which allows the oscilloscope to lock on to sweep or complex waveforms. Other features include TV-V, TV-H trigger, AC, DC, HF-rej, X-Y display. Operation modes include Ch1, Ch2, chop, alt and add.

For further information circle 245 on the reader service coupon or contact Stantron Australia, PO Box 4760, North Rocks 2151; phone (02) 9894 2377.

## Component lead cutter

Computronics Corporation has released the new TP-79 lead cutting machine for radial components. Its heavy duty construction makes it suitable for production environments. A feature of the machine is its gear-driven cutting wheel, which gives a scissor cutting action of a component leg — said to give a better quality cut, longer blade life and easier operation. It has a claimed production rate of 50,000 pieces per hour.

The lead length is adjustable from 2mm to 10mm and the blade can accommodate lead gauges from 0.3mm to 1.2mm. Adjustment is facilitated with



an integrated lead length ruler placed below the moving wheels. A toothed drum ensures leads are parallel during cutting, giving the correct lead configuration for insertion of the component into a PCB. The machine comes with adjustment tools, bandolier holder and a metal collection tray.

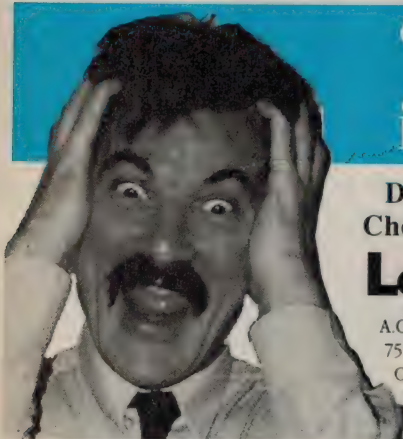
For further information circle 246 on the reader service coupon or contact Computronics International, PO Box 8076, Perth Business Centre, Perth 6849; phone (09) 221 2121.

## 24-pin DIL 4W DC-DC converter

Melcher has released a new family of 4W DC-DC converters in a 24-pin DIL package. Designated the IMX 4 series, the products feature a single substrate planar magnetic design with all components in SMD format mounted directly on a single multi-layer PCB, which is also the main isolating transformer. The converters have a typical conversion efficiency of 82% and a profile of 8.5mm. They have a 4:1 input voltage range with a choice of either 8.4 to 36V DC or 16.8 to 75V DC to suit 12/24V DC, or 24/36/48V DC nominal systems.

They are available with single and dual outputs from 3.3V DC to 15V DC. The units are overload, no-load and short-circuit proof, and are fully rated over the ambient temperature range of -25 to +71°C. An extended temperature range version of -40 to +85°C is also optionally available. Isolation test voltage is 1500V DC. Pin-out choices are available for compatibility to several industry standards, as well as with an SMD version.

For further information circle 247 on the reader service coupon or contact Scientific Devices Australia, PO Box 163, Oakleigh M.D.C. 3166; phone (03) 9569 1366. ♦



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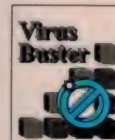
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# WHAT'S BEHIND MPEG DIGITAL VIDEO

Compressed Digital Video (CDV) promises to bring an increase in capacity of at least an order of magnitude into the systems used for delivering video services — satellite, cable, and even the existing terrestrial broadcasting transmitter network. CDV has been the subject of research for at least 30 years, but the remarkably rapid developments that have recently taken place are the result of an unusually harmonious agreement on a set of international standards — the MPEG standards. This article is an overview of the techniques behind those standards, and an explanation of how they can be brought together to form really 'state of the art' transmission systems.

by ROBIN BLAIR

The acronym 'MPEG' stands for Moving Pictures Expert Group, which is formally a part of a joint technical committee formed by the International Standards Organisation (ISO) and the International Electrotechnical Committee (IEC) in Europe. MPEG has been brilliantly successful in developing standards for compressing the data rate required to transmit video services in digital systems.

The Group's initial specifications, commonly referred to as MPEG-1, had reasonably modest objectives, being intended for low resolution pictures such as computer generated images transmitted or stored at data rates up to 1.5Mb/s (megabits per second). MPEG-2, which reached essential completeness only in 1994, extends the capacity to full broadcast standard video, and further developments to accommodate High Definition TV should be agreed in the near future.

The key elements of MPEG address picture coding. MPEG-1 and MPEG-2 share many techniques in common to exploit the redundancies found in typical video data sequences. Adjacent parts

of a scene are often very similar to each other, as are successive frames in the sequence of pictures that comprises the motion picture format.

Where data to be transmitted changes slowly, as with these characteristics, it is intuitively obvious that transmitting the changes is much more economic than transmitting everything — and thereby repeating the static elements over and over. This is the common principle behind Differential Pulse Code Modulation (DPCM) systems. We shall show how these systems have been cleverly adapted by MPEG.

Additionally, MPEG systems do not work on the actual picture elements (the *pixels*) themselves, but mathematically transform the pixel values using the Discrete Cosine Transform or 'DCT'. This transformation gives a stronger correlation between adjacent samples and many of the values generated can be discarded because their absence tends not to be noticed by the human visual system in the reconstructed images. The first property of the DCT makes the DPCM

process much more effective, and the second substantially reduces the number of values requiring transmission.

Having defined picture encoding using these techniques, the MPEG standards next address the coding of the data for transmission. They provide for two common methods of data compression on the transmission link. These are *run-length coding* and *Huffman coding*, the latter sometimes being described as 'entropy' encoding.

All of these processes comprise what is commonly called the 'MPEG toolbox', a fitting name in that the standards allow a system designer to choose some or all of them and the extent to which they are applied in any application.

The system is very flexible, but it is also effective. A few years ago, the standard transmission rate for broadcast quality video distribution was regarded as 144Mb/s. Some users came to accept 34Mb/s with the development of early compression systems, but now 8, 6 or even 5Mb/s is generally considered adequate with MPEG-2. Indeed, forthcoming enhancements will soon allow the data rate to be varied dynamically, or 'on the fly' as it were, according to the nature of the program material being transmitted at any instant.

Let us now look at some of the elements of the standards.

## Differential coding

Although MPEG does not use DPCM as such, the philosophy behind DPCM is a very useful tool in developing an understanding of the MPEG techniques.

Consider the simple DPCM system shown in Fig.1, and suppose it is transmitting some signal where the value of

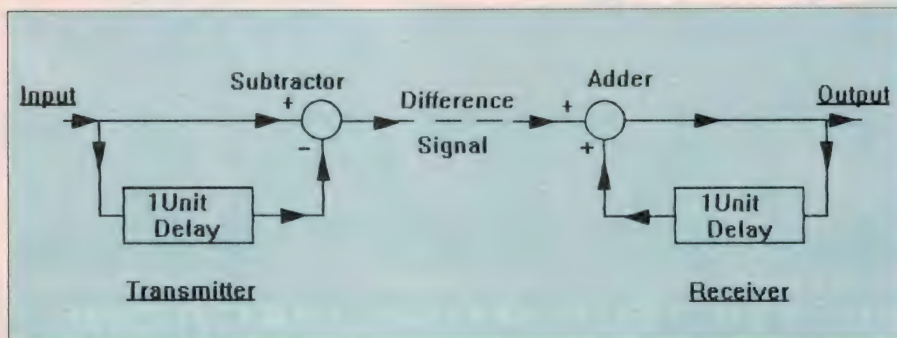
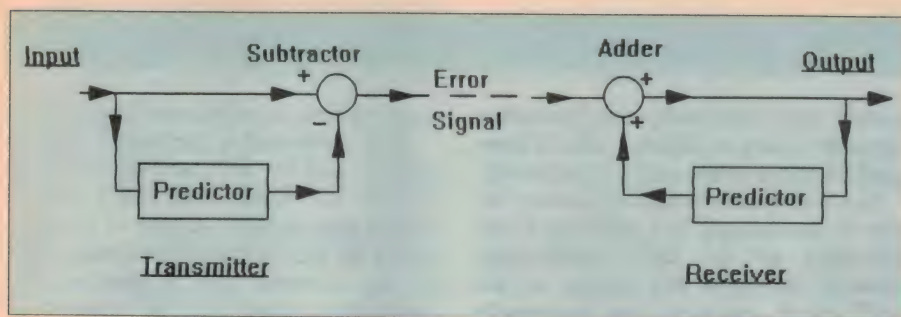


Fig.1: A rudimentary differential data transmission system, designed to transmit only the difference between successive symbols, to reduce the transmission rate.





**Fig.2:** The simple one-symbol delay elements of Fig.1 can be replaced with 'predictors', to achieve an even higher reduction in transmission rate. However this arrangement has a serious deficiency.

each successive symbol depends strongly on that preceding it, as happens for example with the pixels in a video signal. This system, as drawn, transmits only the *changes* between symbols, and the actual symbol values are recovered by the circuitry around the delay unit in the receiver, whereby the previously derived value is systematically added to the change value as it is received. The reader is invited to 'plug in' a simple sequence of numbers, to see that this rudimentary arrangement really does work.

In Fig.1, the function of the delay line in the transmitter is essentially to 'predict' (or guess) the value of the next symbol to be transmitted. If this prediction is reasonably accurate, then the DPCM system needs to transmit only the errors, and the numerical range of the errors should be much smaller than that of the original symbols — leading to a considerable reduction in the data rate.

The system as drawn uses only the value of the previous symbol as the prediction. But obviously if we could exploit some stronger property of the data stream to form a better estimate, the range of the errors and the data rate could be reduced even further. This is the essential principle of MPEG.

On this principle, we can replace the simple delay units in Fig.1 with 'predictors' and arrive at the system shown in Fig.2.

Ideally, this can work but it suffers from the very serious deficiency that the predictors in the transmitter and receiver operate on essentially different signals. This makes designing the two predictors to track each other accurately very difficult, particularly when some processing of the transmitted signal, like quantising, is introduced.

Fortunately, there is a way around this by embedding the predictor in a feedback loop at the transmitter, as shown in Fig.3. This figure shows a quantiser in the transmission path, to more accurately represent a real system and to illus-

trate the point that the two predictors here operate on identical signals.

Fig.3 is the essence of the MPEG picture encoding system. The better we can make the predictors, the lower will be the data rate we have to transmit.

The very clever part of the MPEG standards is in the prediction algorithms. But before addressing that, let us divert to the two coding methods mentioned above, run-length and Huffman coding, as they have a bearing on how the prediction algorithms have been chosen.

### Run-length coding

In some classes of data, particularly that arising from video pictures or facsimile scans, one often finds long strings of numbers with a constant value, especially zero. It is more efficient to transmit such material as only two numbers — the constant value and the number of symbols in the run — rather than transmit the full sequence of the same number. This is known as run-length coding, or more often variable run-length coding (VRLC).

If one can transform the raw data in some fashion to make these strings prevalent, then a reduction in the required transmission rate may well

result. We shall see shortly that MPEG achieves this by way of the Discrete Cosine Transform mentioned above.

### Huffman coding

Huffman coding, named after its inventor, is an example of *entropy* coding, and is simple in principle. Each symbol (or value) to be transmitted is assigned a binary code word of some number of bits. Words with a small number of bits are assigned to those symbols which occur more frequently, and longer words are assigned to symbols which occur only rarely. As a result, fewer bits need be transmitted than in a system where all symbols are assigned words of equal length.

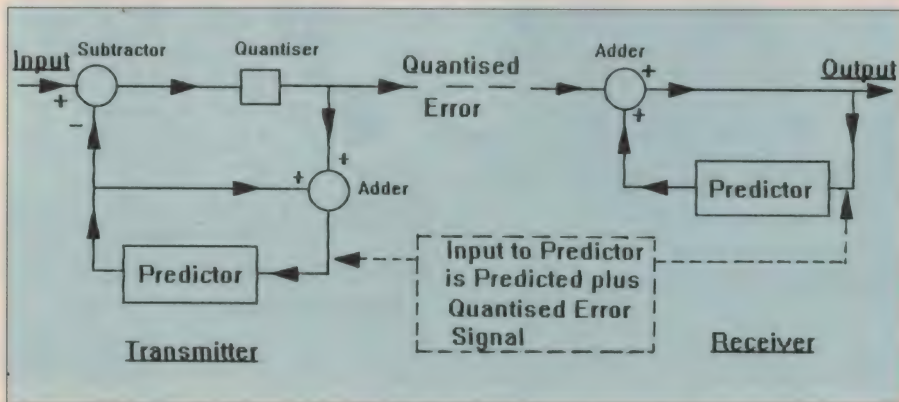
A well known example of the principle occurs in the Morse code. Huffman invented a systematic way of assigning words to values, which has been adopted in the MPEG standards.

Huffman and run-length coding are quite standard techniques in all classes of data transmission, and they are 'lossless' in that, barring transmission errors, the original data can be regenerated exactly. This is not the case with the other techniques used in MPEG, in which the data (for example pixel brightness) may be reproduced only approximately by the predictors in the transmitter and receiver.

The art of MPEG has been not only to make this 'lossy' data reconstruction subjectively acceptable, but also to format the transmission parameters to make the lossless techniques particularly effective. The Discrete Cosine Transform, which we now address, is an important element in this process.

### Discrete cosine transform

The discrete cosine transform or DCT is very closely associated with the Fourier Transform, and like the



**Fig.3:** To ensure that the predictors at the transmitting and receiving ends operate on identical signals, for correct operation, the transmitting predictor can be embedded in a feedback loop.



latter, may be considered to extract the 'frequency components' in a sequence of samples.

In MPEG the DCT operates over blocks of eight rows by eight columns of pixels in the video picture, giving 64 binary numbers to be transformed in each block. The rows are runs of eight pixels taken from each of eight successive scanning lines, and on the picture screen each block comprises a small square area of adjacent pixels.

The process is illustrated in Fig.4, which purports to show a block of pixel values transformed into a similar block of DCT coefficients. (For simplicity, Fig.4 shows only 4x4 blocks.) In a sense, the DCT coefficients across the block are a measure of the frequency components in a horizontal scan of the picture block, and those down the block a measure of frequency components in a vertical scan.

Higher frequency DCT coefficients occur towards the right and bottom of the block, and have large values only in busy scenes with a lot of detail. These values approach zero in scenes with little changing detail, such as pictures of the sky for example. On the other hand the overall average brightness of the pixel block is represented by the coefficient in the upper left hand corner.

Fig.4 attempts to show two common properties of the DCT that occur in most video applications. Normally the higher frequency DCT components diminish rapidly in value away from the top left

corner, and additionally the correlation between values in adjacent cells is more marked than with the original pixel block.

In viewing a reconstructed picture, the eye is increasingly less sensitive to the accuracy of the DCT coefficients towards the right and bottom of the DCT block, and these can be coarsely quantised or set to zero, according to the quality of reproduction desired.

On the other hand, the coefficients towards the upper left corner govern the overall brightness of each reconstituted block of pixels, and must be quantised finely and transmitted accurately. Otherwise, the brightness in the reconstructed scene tends to change abruptly from block to block, leading to a chequerboard effect commonly called 'blockiness'.

To exploit these properties further, MPEG uses a scanning sequence in each DCT coefficient block (i.e., each pixel block after DCT processing) like that illustrated in Fig.5(b), rather than what might be considered the more 'natural' sequence in Fig.5(a). Notice that this gives a smooth transition through adjacent values, avoiding large jumps in magnitude. It can also generate long runs of zeros or constant values where the higher frequency DCT coefficients are coarsely quantised or set to zero. The first property favours efficiency in the DPCM process, as explained above, and the second neatly fits in with the variable run-length coding used on the trans-

mission link, as mentioned previously.

The relationship between picture quality and the accuracy or transmission of the higher order DCT coefficients adds another degree of flexibility in MPEG. It should be evident that in the inherent DPCM process, the prediction error will be greater in rapidly changing scenes and would ideally be transmitted at a higher data rate than otherwise. However, this is generally difficult in a world where most digital links have a fixed rate.

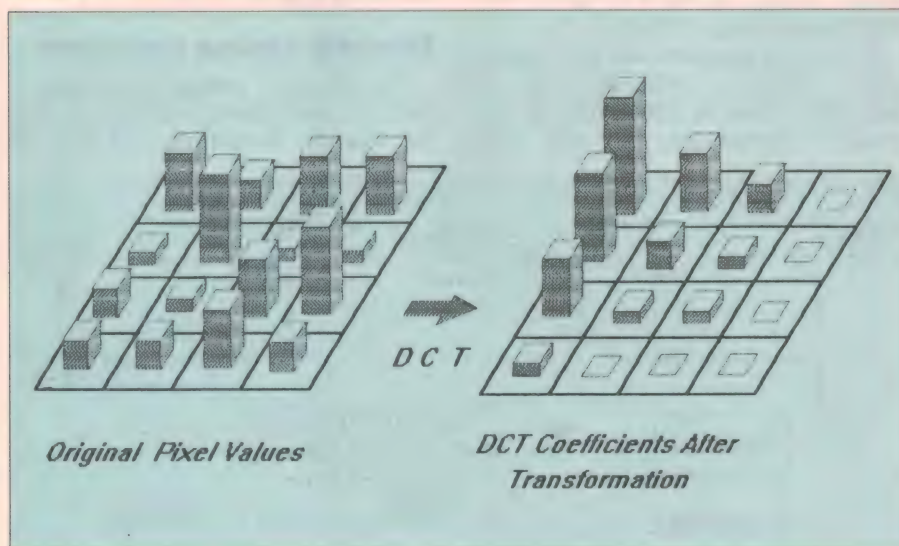
With MPEG, the outgoing data is stored in a buffer which is emptied at the fixed transmission rate but can be filled at a varying rate. If the buffer tends to overflow, a feedback loop into the picture coder causes the quantising of the higher order DCT coefficients to be made coarser, decreasing the volume of data, and increasing the prevalence of long run lengths of fixed values — thus favouring the variable run length coding.

As a result normal picture sequences are encoded to the defined quality, but this quality declines for 'busy' sequences or those with rapid motion. It is in just these circumstances, however, that the eye is least sensitive to picture quality. In a sense, MPEG achieves the desirable aim of matching its coding to its channel, of which the human visual system forms part.

## Motion prediction

We have seen that the major essence of MPEG systems, arising from the principles of DPCM, is that they should transmit only the differences between a current block of data and a predicted block of data derived from what has gone before. The smaller this difference, the smaller the required data rate. In other than still pictures, the blocks of data will change position from frame to frame, and in predicting the values of a particular block, the MPEG predictor could very usefully use information on where the block came from in previous frames. Effectively, the predictor should keep track of moving blocks, as they change relatively slowly within themselves, compared to how quickly a block in a fixed position on the screen would change when motion is present.

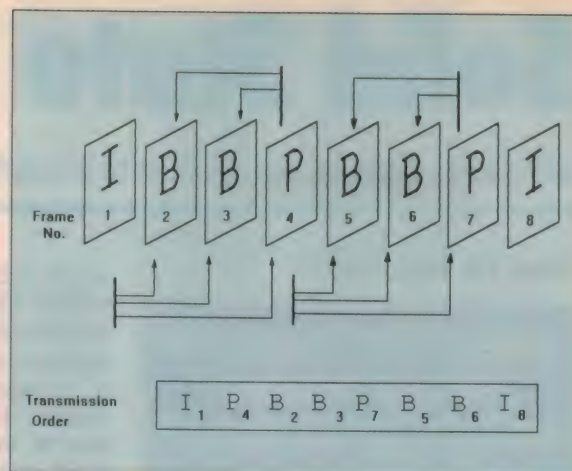
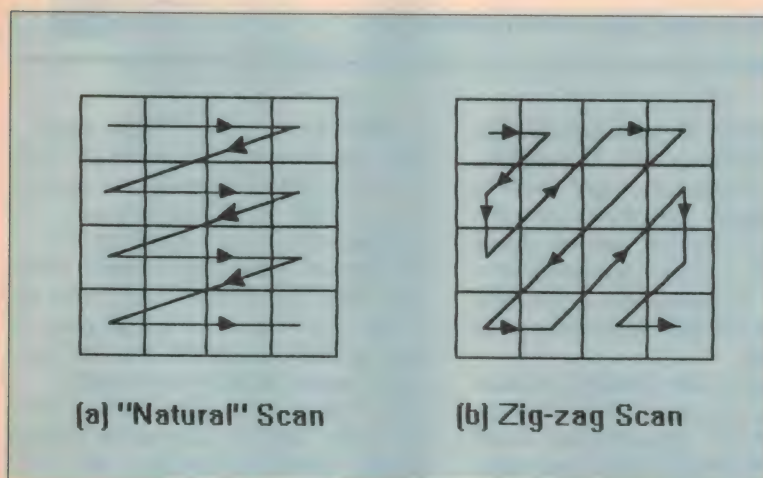
Think, for example, of the situation of a camera scanning a crowd scene. If we could track an individual face through the sequence of picture frames, the pixel blocks within that face might stay essen-



**Fig.4: The discrete cosine transform (DCT) is used to analyse the content of each group of pixels, and replace them with a set of 'spacial frequency' coefficients. As these are highly correlated they can be transmitted more efficiently — and higher-order coefficients can be omitted without serious degradation.**



**Fig.5 (below):** Although one might expect the pixels in each picture block to be scanned in traditional 'line by line' fashion, their DCT coefficients are scanned in zig-zag fashion — starting with the DC component and ending with the highest frequency component.



**Fig.6:** The various MPEG image frames are actually transmitted out of order, so that the 'dependent' B and P frames follow the stand-alone I frames from which they are derived. At the receiving end, the MPEG decoder restores them to their correct order.

tially unchanged in their values.

To give effect to this technique, MPEG systems transmit with each DCT block a 'motion vector' indicating the velocity of the block across the screen in the horizontal and vertical directions. This tells the predictor in the receiver where the block is likely to be next — or perhaps we could better describe this as the receiver knowing where the block came from, to determine what its values were last time.

There are various ways of estimating the motion vector, but most involve the transmitters moving the 8x8 pixel block around a 16x16 'macroblock' in adjacent picture frames, to find the position of best fit. This process, incidentally, is not defined by MPEG, which confines itself to requirements at the receiving end. Hence, the standards leave room for innovative solutions.

## MPEG frame structure

As we have described it so far, the DPCM process embedded in MPEG has two problems. Essentially, it has to *start* somewhere — we cannot have a cascade of picture frames all derived from those that came before, and not have a beginning. Secondly, transmission errors will propagate and affect all frames after that in which the error occurs. Additionally, in video there must be frames capable of standing alone, to permit editing, cutting and splicing of program segments.

To satisfy these considerations, MPEG defines three *types* of frames to be transmitted. The first, called Intra-Frames or 'I' frames, are stand-alone and independent of any previously transmitted frames. They are encoded

entirely from within themselves and achieve only a moderate degree of compression.

The second type comprises the Predictive frames or 'P' frames. These are coded using motion compensated prediction from previous I and P frames. They achieve considerably more compression than the I frames.

Finally, there are the bi-directionally predicted or 'B' frames. These are derived from past and future I and P frames, and are not used for further predictions. They achieve the highest degree of compression.

The diagram in Fig.6 shows a typical sequence of frames and the interdependencies between them. Note that the frames are not transmitted in this order, as it considerably simplifies the receiver design if the P and B frames follow those on which they depend.

The table in Fig.6 shows the sequence in which the frames would actually be transmitted. (Note that this is a little simplified for clarity. In practice there would be B frames between P7 and I8, backwardly dependent on I8.) The out-of-sequence transmission does require frame storage in the receiver, and the standards do define a 'simple profile' which omits the B frames.

## Profiles and levels

The MPEG standards define 'profiles' and 'levels'. The *profile* essentially describes the features of the toolbox that are included in a particular system, including some features not yet finalised such as scaling the fineness of quantising according to the signal to noise ratio. The *level* largely defines the input source parameters, such as the maxi-

mum sampling rate.

At present, readers are most likely to encounter the *main profile, main level* system, suited to 625-line PAL displays.

## The future

MPEG is ongoing and we can expect to see further developments in future. However its main value may lie in the influence it has had in the standard-setting scene and the powerful industry committees that have emerged in its wake.

These committees are loosely associated with the international standards setting bodies, but are far more like consortiums of the larger industrial organisations than has previously been the case in setting international standards. They are much more quickly moving than the traditional committees dominated by Government bureaucracies.

The two major examples are the DVB (Digital Video Broadcasting) Committee and DAVIC (Digital Audio Video Council). DVB tends to focus more on matters affecting transmission standards, whereas DAVIC has done much work on defining customer interfaces in areas like security and billing. Both are achieving an unprecedented rapid agreement on how to incorporate the MPEG standards into real-life systems, and we should see the results of their labour very soon.

In part, the committees arose from the debacle surrounding the aborted development of High Definition TV, where fiercely competing systems destroyed each other. Hopefully they represent a new degree of cooperation in this industry. ♦



# Solid State Update



KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

## Tiny 1A regulator



Burr-Brown's new SOT-223 package REG1117A adjustable voltage regulator has an output current up to 1A and an output voltage that is programmed with two external resistors. Features of the device include a dropout voltage of 1.5V max at 1A output current, internal current limit and thermal overload protection. It is also claimed to have excellent output voltage regulation for changes in line, load, and temperature. Applications include computers, PDAs, portable instruments and battery powered medical equipment.

For further information circle 284 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

## 200kHz 12-bit ADC with sleep mode

Burr-Brown's new ADS7816 is a 12 bit, 1.9mW sampling A/D converter packaged in a compact 8-lead SOIC. The device is suited to a wide range of general purpose applications including high speed modems, digital signal processing, speech recognition, medical instruments and personal digital assistants. Its low power consumption and

small size means it's also suitable for remote and isolated data acquisition, transducer interfacing, and battery operated systems. The device includes a between-conversion power down feature, when it takes a quiescent current of 1uA. At power-up, it provides valid data on the first conversion with no clock delay.

Specifications and features include: 200kHz sampling rate, 1.9mW dissipation at 200kHz, synchronous serial interface, differential input and automatic power down. It is available in an 8-pin plastic mini DIP and an 8-lead SOIC package.

For further information circle 275 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

## DDS ICs have a resolution of 0.01Hz

Analog Devices has introduced two 10-bit direct digital synthesizers (DDS), said to give a low-cost and easy way to build circuits for direct digital frequency tuning and digital demodulation. The AD9830 (50MHz) and AD9831 (25MHz) have a low operating power (300mW and 45mW respectively), and suit communication, industrial, and test and measurement equipment applications. The AD9830 requires a +5V power supply, and the AD9831 operates from either a +3V or +5V supply.

Direct digital synthesis can control the frequency and phase of an output sine wave to extremely high resolution, which according to the company usually needs complex and expensive components that take up to 1.5W of power. These new ICs are claimed to overcome these problems. For example, to reduce complexity the devices integrate a phase accumulator, sine wave look-up table and a 10-bit DAC to generate the output signal. The chips also have four phase and two frequency registers for FSK (frequency shift keying), PSK (phase shift keying) and QPSK (quadrature phase shift keying) modulation. Both devices resolve frequencies to one part in four billion, or to 0.01Hz, and phase control extends to within 0.08°.

At 5V, the SFDR (spurious free dynamic range) for both devices is

—72dBc for a narrow band input, -50dBc for wide band. Typical DC error is  $\pm 0.5$  LSB differential nonlinearity and  $\pm 1$  LSB integral nonlinearity over a temperature range of -40 to +85°C. The devices also have a sleep mode, when they take 0.25mA, and 'wake up' in 1ms. They can drive a wide range of loads at different speeds and full scale output current is set by one resistor.

For further information circle 272 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

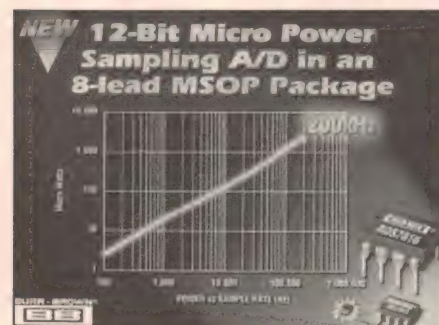
## Serial stereo audio CODEC



Burr-Brown's new PCM3000/3001 is a low cost, single chip, serial interface stereo audio CODEC (analog to digital and digital to analog converter) with a single-ended analog voltage input and output. The ADC core employs delta-sigma modulation with 64X oversampling, a digital decimation filter and a high-pass filter. The DAC core has a multi level delta-sigma architecture which includes an 8X oversampling digital interpolation filter, digital attenuation, de-emphasis, infinite zero detection and soft mute, to form a complete subsystem.

Applications include a wide variety of general purpose consumer applications including sampling keyboards, digital mixers, surround-sound processors, MiniDisc recorders, hard-disk recorders, karaoke systems, DSP-based car stereo systems, DAT recorders and video conferencing.

The device accepts 16 or 18-bit data in left justified, right justified, I<sup>2</sup>S, or DSP formats. The PCM3000 can be bit-mapped with a three-wire serial inter-





face for special features and data formats. The PCM3001 can be pin-programmed for data formats. Specifications include a 94dB dynamic range and 94dB SNR (ADC), 96dB dynamic range and 98dB SNR (DAC), system clock (256fs, 384fs or 512fs), single +5V supply and multiple sampling rates. Both devices are available in a small 28-pin SSOP.

For further information circle 273 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

## Blue LEDs

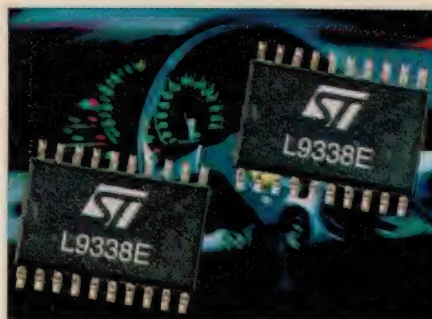
The Electronic Products Group of Dialight Corporation has added blue LEDs to its 249 and 507 series of panel mount indicators. The 249 series is for 9.5mm (3/8") hole mounting and is available in cylindrical or stovepipe cap versions, with a forward voltage of 3V, 5V, 10V, 14V and 28V, at 10mA. The 507 series of cartridges have the same performance specifications, but are used with holders and clips. Housings, cartridges and holders for both series are made of black anodised aluminum. Lens caps are of high-impact plastic.

For further information contact Dialight Corporation, 1913 Atlantic Avenue, Manasquan, NJ 08736; phone (908) 223 9400, fax (908) 223 8788.

## Quad driver for automotive uses

Aimed at both the automotive and industrial markets, the SGS-Thomson Microelectronics L9338 Quad Low Side Driver IC contains four driver channels, each equipped with a logic input and an open-drain output stage. Each channel includes a DMOS output transistor with an ON resistance of 1.5Ω at 25°C and an output clamp for inductive loads. The output slope is controlled to minimise electromagnetic interference, and has over-temperature protection. A diagnostic output indicates protection function status and open load conditions. To allow fail safe design, the outputs default to a defined state in case of open circuit inputs.

In standby, the IC consumes less than 2uA. It operates with a supply voltage from 4.5V to 45V and is reverse bias protected up to -24V. The circuit is supplied in an SO-20 surface mounting package. Typical automotive applications include driving relays in engine or body control units, or driving lamps in dashboard instruments. Industrial uses include a relay driver in programmable controllers or as a line driver in noisy electrical environments. The device



architecture is based on the company's bipolar-CMOS-DMOS mixed smart power technology.

For further information circle 274 on the reader service coupon or contact SGS-Thomson Microelectronics, Suite 3, Level 7, 43 Bridge Street, Hurstville 2220; phone (02) 9580 3811.

## Preamp improves speech intelligibility

The new SSM2166 from Analog Devices is a smart preamplifier system-on-a-chip that features variable compression and automatic noise gating, to give improved intelligibility to microphone-level signals of up to 20kHz. It is claimed to be able to recognise and compensate for poor signal level conditions and give improved fidelity. The device's compression ratio can be customised from 1:1 to 15:1 with a single external resistor, allowing it to produce an essentially steady, undistorted audio output level, despite input signal variations.

In a microphone application the IC will attenuate very strong signals or amplify weak signals, giving an output that is virtually independent of the user's distance from the microphone. The preamp also features an automatic noise reduction circuit that reduces background noise and hum, especially with weak input signals.

The device is claimed to give almost distortion-free amplification, and also compresses input signals to prevent overloading an analog to digital converter. It is well suited as an input conditioner for Analog Devices' AD18xx series of codecs.

It operates from a single +5V supply and comes in a single 14-pin SOIC or plastic DIP package. Its input buffer can be configured for an overall gain of 0dB to 20dB. Applications include computer sound cards, public address systems, communication headsets, telephone conferencing, audio effects generators and surveillance systems.

For further information circle 278 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

## QUICK EASY DATA ACQUISITION & CONTROL

The DAS005 Data Acquisition Module simply fits to an IBM PC printer port. Measuring 60 x 55 x 20mm it features a 12 bit ADC, 4 Digital Inputs and 4 Digital Outputs. The ADC has 8 SE inputs each with a range of 0-4V and able to tolerate faults to +/-20V.

In addition is the Windows program I-SEE to monitor the inputs, display graphs, control outputs and log readings to disk. C, Pascal, QuickBasic & Visual Basic functions are included for those who wish to write their own programs.

Price is \$120 (sales tax excluded) plus \$8 postage.

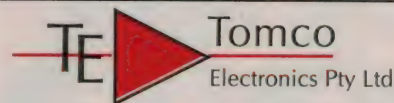
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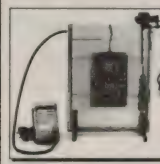
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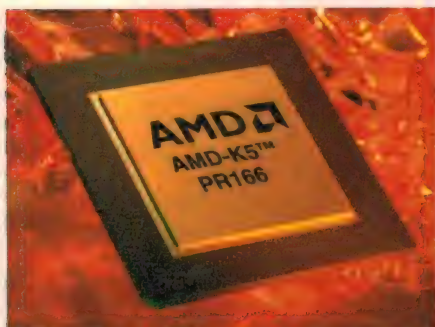
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## SOLID STATE UPDATE

### Alternative to 166MHz Pentium

AMD has announced its AMD-K5-PR166 processor, targeted for the mainstream desktop personal computer market. The new processor is claimed to have a performance equal to or better than a 166MHz Pentium, as indicated by its P-Rating. The P-Rating is based on the Ziff-Davis Winstone 97 benchmark suite, and is said to provide a single, meaningful measurement of true system performance provided by a processor.



AMD also announced that Acer America Corporation will use the processor to power two new members of its AcerEntra value-priced desktop computer line. AcerEntra is Acer's branded basic system that is customised by resellers for their customers.

For further information circle 271 on the reader service coupon or contact AMD Australia, Level 14, Berry Street, North Sydney 2060; phone (02) 9959 1937.

### Op-amps in tiny MSOP-8 package

The new Burr-Brown OPA234 is a low power, single supply op-amp in a tiny MSOP-8 package, which has the same number of pins as an SO-8 surface mount package, but is half the size. It is aimed at all types of portable and battery operated instruments, including PCMCIA cards.

The device is available in dual (OPA2234), and quad (OPA4234) versions, and can operate from single or dual supplies. In single supply operation, the input common-mode range extends below ground and the output can swing to within 50mV of ground. At unity gain it is stable with up to 10nF of load capacitance.

Specifications include +2.7V to +36V (+/-1.35V to +/-18V) supply range, 250uA/amplifier quiescent current, 25nA max input bias current and a



150uV max offset voltage. The single and dual versions are also available in 8-pin DIP and SO-8 surface mount packages and the quad version also comes in 14-pin DIP and SO-14 surface mount packages. All are specified for the -40°C to +85°C temperature range.

For further information circle 282 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

### Wireless LAN transceiver IC

Harris Semiconductor has released the HSP3824, a direct sequence spread-spectrum wireless LAN transceiver capable of supporting data rates up to four million bits per second. It is claimed to simplify the development of IEEE 802.11 wireless local area networks (WLAN).

The device combines on-board A/D converters, an IEEE 802.11 packet-generation state machine, a DBPSK/DQPSK differential data encoder, a seven-tap data scrambler, a PN-code data spreader, and a media access control-to-physical layer interface (MAC-to-PHY) optimised for IEEE 802.11. It handles up to 4Mb/s continuous or packetised data at a 22MHz chipping rate. The IC can generate its own synchronisation preamble and header, or accept the preamble and header information in the MAC data packet.

The transceiver allows either dual antennas to compensate for multipath interference losses, or a single antenna for fast acquisition times. In dual-antenna diversity mode, the antennas are



scanned to find the one with the best representation of the signal, based on two measures of signal quality. An 8-bit test port on the device allows internal signals to be brought out for real time monitoring during compliance testing.

For further information circle 280 on the reader service coupon or contact B.B.S. Electronics Australia, Unit 24, 5-7 Anella Avenue, Castle Hill 2154; phone (02) 9894 5244.

### High performance FET input op-amps

Burr-Brown has released the OPA134 (single) and OPA2134 (dual) FET-input operational amplifiers, designed for high performance audio applications. Their true FET-input stage is said to provide a superior sound quality and excellent dynamic characteristic, making the devices suitable for professional and high performance audio applications, including recording, reproduction, broadcast and multimedia equipment. Other uses include general purpose applications requiring low distortion, such as active filters and test instrumentation inputs.

According to Burr-Brown, the op-amps are unity gain stable and free from phase inversion and overload problems commonly found in FET-input op-amps. A fully cascoded input stage ensures that input bias current remains virtually constant throughout the common-mode range for lowest distortion. The OPA2134 (dual) features independent circuitry for lowest crosstalk and freedom from anomalies when one amplifier is overdriven or short-circuited.



Device specifications include 8MHz gain bandwidth, 20V/us slew rate, and 0.00008% THD+N at 1kHz! Low noise input circuitry limits voltage noise to 8nV/√Hz. Power supply range is +2.5V to +/-18V. Both devices are available in 8-pin DIP and SO-8 surface-mount packages, and are specified for -40/+85°C operation.

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# Silicon Valley NEWSLETTER



## NEC announces 4-gigabit DRAM

In a major technological achievement, Japan's NEC has developed a working prototype of a four-gigabit DRAM memory chip. The company hopes to ship samples as early as 2000 with production starting around 2001.

The NEC move comes at a time when most major DRAM producers have yet to complete development of a 1Gb circuit and have not or barely initiated programs aimed at a 4Gb chip. Only recently, for example, Texas Instruments, Hitachi and Mitsubishi formed an alliance to share the cost of developing a 1Gb DRAM.

NEC said it wants to move fast in bringing the new chip to market, hoping to beat its rivals to the market. The company said it used 0.15 micron process technology to develop the chip. This means circuits etched into the surface of the chip are so narrow that 600 can be laid side-by-side on the width of a human hair.

The NEC chip can store the equivalent of 16,000 newspaper pages, compared to about 128 pages for today's 16Mb devices. By the time it goes into production the company expects to have a 1.3um process in place, allowing it to shrink the size of the chip to about half its current size.

NEC believes the 4Gb memory will have major applications in multimedia computing, as a standard set of eight such chips can store up to 47 minutes of full-motion video, or six hours worth of audio data.

If NEC is able to bring the 4Gb chip to market around 2001, the company is likely to gain a huge lead over its competition. Today, 64Mb chips are just getting into volume production at plants around the world, and demand is not expected to peak until late 1998 or 1999.

**At the recent Las Vegas CES Panasonic released its 'TruPhoto' digital photo printer, which uses no ribbons, ink, toner or chemicals. The company's new Thermo Autochrome paper technology allows it to produce glossy 75 x 125mm prints. It's expected to retail for around US\$500.**

Subsequent 256Mb DRAM demand is expected to reach its high-point around 2000, with 1Gb chips not running in mass quantities until 2002. Those timetables may be set back even further if DRAM prices remain depressed throughout 1997 and into 1998.

## Intel shows off 400MHz Pentium

Microprocessor speeds have still not reached their limits, as shown by Intel in demonstrating a prototype of an MMX-based Pentium processor running at 400MHz — double the current top speed of 200MHz.

Business and consumer users will probably have to wait until late this year before they can enjoy that level of performance in a personal computer, said Intel spokesman Howard High.

Intel demonstrated the chip during the International Solid State Circuits Conference (ISSCC) in San Francisco, an annual event where semiconductor companies show off their latest state-of-the-art designs and innovations to an audience of several thousand system and chip engineers.

The 400MHz chip was produced on a 0.35um production platform. However Intel is planning to manufacture the chip on a new state-of-the-art 0.25um production line now under construction.

Even at 400MHz, the Intel processor will not be the fastest PC processor on the market. Exponential Technologies in San Jose launched a PowerPC clone chip that runs at 530MHz. The chip is expected to show up in Apple Macintosh and Mac clones around the middle of this year.





## TI launching 'Super DSP' chips

Texas Instruments is launching a new family of parallel processing digital signal processors (DSPs) that operate at speeds of up to 1.6 billion calculations per second. The chips will be aimed at applications such as cellular telephone switching equipment and Internet servers. Rather than speeding up the transmission of data between two points, the new TI chips will enable network and communications systems to handle multiple incoming signals simultaneously.

In an Internet server application, a single TI DSP chip will be able to manipulate signals from 24 calls at once. It currently takes 24 separate DSP chips to accomplish the same task.

The chips feature eight parallel processing units onto a single chip — four times the number of TI's current parallel processing DSP family. The so-called C6x chip, with a processing capability of 1.6GHz, is about 120 times faster than the DSP chips used in most of today's computer modems, which handle data at up to 33kb/s.

TI senior vice president John Scarisbrick said TI expects to be in full production with the C6x chip in the second half of this year. Mr Scarisbrick predicted that the chip could become a standard in future communications devices, including PC modems. "We'd be surprised if we weren't producing millions of units by the end of the decade — perhaps tens of millions."

Texas Instruments is already the world's leading supplier of DSP chips, with a marketshare of 45% in a US\$2.5 billion market.

## Intel chip assembly moving to Philippines

The semiconductor assembly industry in the Philippines received a huge boost when Intel announced plans to move all of its semiconductor assembly operations to the island nation by the year 2000. As part of the conversion, Intel will invest some US\$600 million in the expansion of existing facilities.

During the mid-to-late 1980s, the Philippines lost much of its position as the world's most popular source for IC assembly operations as Singapore, Malaysia, and Thailand competed effectively for the business. The political unrest in the country during this period contributed to several companies deciding to take their business elsewhere. But in recent years the industry has returned in a big way.

Major semiconductor firms from both

## Revolutionary insulator speeds up chips fourfold

Plasma & Materials Technologies, a semiconductor equipment manufacturer from Chatsworth in Southern California, has announced what may amount to a revolutionary chip production technology that promises to increase the processing speed of microprocessors and other chips by as much as a factor of four.

The company said it has developed a better method for depositing a silicon-dioxide-based insulator on the surface of integrated circuits. The insulator material separates IC components such as transistors and interconnections. The new method dramatically reduces the amount of cross-signal interference in the chip, a phenomenon that is becoming an increasing problem as chipmakers pack transistors and interconnects closer and closer together.

Plasma said its process is currently being tested by several major semiconductor manufacturers. The first devices produced with the new insulator, should the technique be found feasible for commercial mass production applications, could be as early as next year.

Plasma's insulation material has a dielectric constant (a measure of its effectiveness) below 2.0 — considerably lower than constants of about 3.5 for today's most efficient insulators. As a result, chipmakers will be able to dramatically shrink the space between components without any increase in cross signals. That of course will reduce the time in which electrons complete their journey through the chip, resulting in much faster processing speeds.

Currently, dielectric materials are deposited onto the chip in chemical vapour deposition (CVD) systems in which the silicon dioxide is injected into the reactor chamber in a gas form that hardens as the atoms hit the chip's surface. The Plasma method uses a so-called 'flowfill' process in which the insulator is applied in a liquid state. To enhance the dielectric constant, Plasma added a small amount of carbon to the silicon-dioxide mix.

"This is a major improvement", said Daniel Klesken, a semiconductor analyst in San Francisco. "It's all about having a nice clean signal between the different transistors on the circuit."

Greg Campbell, founder and chief executive of Plasma & Materials Technologies, said that Intel was not currently one of the companies testing its manufacturing process. Campbell said the main hurdle to his production technique gaining industry acceptance is demonstrating "it's truly reliable in mass production."

the US and Japan have started up or expanded their Philippine production. Texas Instruments' microchips are now the Philippines' biggest export; Motorola's chip plant in Manila has won a company-wide quality award for four years in a row.

When completed, the Intel expansion project will double the firm's Filipino labor force to more than 3000 people. Intel originally invested some US\$400 million in plants and equipment there.

## Hitachi, Mitsubishi & TI team up for 1Gb DRAM

Three major DRAM memory manufacturers — Hitachi, Mitsubishi and Texas Instruments — have agreed to share the cost and effort in the development of future one-gigabit DRAM chips. The move extends a trend on joint R&D in the development of advanced future generations of DRAM chips that started in the mid 1980s, when the cost of developing such chips skyrocketed.

In 1988, for example, TI and Hitachi teamed up on the development of 16Mb chips, a deal that continued with the development of 64- and 256-Mb designs.

In 1995, Hitachi and TI also formed a joint venture called TwinStar Semiconductor, a half-billion dollar wafer fabrica-

tion facility located in Richardson, Texas. Meanwhile IBM, Toshiba, and Siemens have been close partners since the early 1990s on the development of 64- and 256Mb DRAMs, and they are expected to continue the relationship into future generations.

Industry analysts expect the trend towards sharing R&D costs in the semiconductor industry to intensify under the current poor DRAM market conditions, which have eroded all but a tiny sliver of profitability on the production of 16-megabit chips.

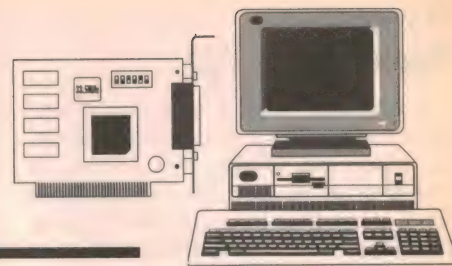
Chipmakers, however, cannot afford to fall behind on the timetables for development of future generations of DRAMs. The volatile DRAM market can turn highly profitable almost overnight, when a combination of strong demand and low capacity creates shortages of memory chips.

The TI-Hitachi-Mitsubishi agreement will allow the three chipmakers to share the nearly US\$1 billion that will be required to design the 1Gb chips and develop the necessary production techniques, processes, and equipment to manufacture them.

A spokesman for Mitsubishi said the company is aiming for sample shipments of 1Gb chips by early 2000. ♦



# Computer News and New Products



## Large screen monitor/TV

VoicePerfect has announced the Australian release of a range of five large screen, computer SVGA monitor/TVs. The sets are available in screen sizes of 50cm (20"), 71cm (28"), 74cm (29"), 84cm (33") and 94cm (37"), and are manufactured in ISO9002 certified factories by Chun, claimed to be the largest Taiwanese manufacturer of large monitors, televisions and TV walls. According to VoicePerfect the sets 'represent excellent value because they combine a large screen, high resolution computer monitor with an inbuilt TV tuner, and suit PAL and NTSC video systems'.

The monitors can be connected to notebook and laptop computers, standard or multimedia PCs, Apple Mac and PowerPCs, and LAN stations. They also have two composite video inputs, an S-video input, and two audio input/outputs, so they can be used as a conventional television set for operation with a video CD player, VCR and so on. They feature a 4R super flat-screen colour picture tube, said to display images clearly without distortion in the corners of the screen.

The sets are compatible with VGA, SVGA, 8514A and VESA video boards. The MAC II attachment is an optional extra. They support a maximum resolution of 1024 x 768 pixels with a dot pitch of between 0.78mm and 0.83mm. Scanning frequencies are horizontal 15.75kHz, 31-38kHz and vertical 50-100Hz. Also featured are a 120-minute sleep timer and a range of picture quality improvement circuits which



boost image quality, clarity and colour fidelity.

For further information circle 160 on the reader service coupon or contact VoicePerfect, 36/456 St Kilda Road, Melbourne 3004; phone (03) 9866 6700.

## Multi-axis motion controller

Optimised Control has released a PC-compatible multi-axis motion controller board, with control facilities for up to eight axes of stepper, servo and CAN-based motor drives. It is suited for machinery and automation applications.

Called NextMove-PC, the ISA/PC-AT bus module is based



on a 32-bit DSP, with high level programming support using the MINT language. The design upgrades an earlier version of the board with a second CAN (controller area network) channel to support systems requiring tightly coupled axes. It also has a mezzanine interface accepting further plug-in servo or stepper control channels, plus comprehensive support for Windows programmers.

In its standard form, the board offers four axes of closed-loop servo control with a 250us loop update capability, four axes of open-loop stepper control with a maximum step pulse frequency of 200kHz, plus two 1Mbits/sec CAN channels for linking with remote drives and I/O.

Included is enough on-board I/O to satisfy many common machine or automation tasks. There are 24 user-configurable opto isolated digital inputs, 12 opto isolated outputs capable of providing up to 350mA, plus eight 12-bit analog inputs which can be used as single-ended or differential channels. Further I/O can be added via CAN. The new Windows toolkit option, supplied in the form of 16 and 32-bit library functions, allow designers to interface the controller with Windows 3.1/95/NT machine control environments.

For further information circle 168 on the reader service coupon or contact Optimised Control (NZ) Ltd, 5 Matija Place, Red Beach, Hibiscus Coast, New Zealand; phone +64 9426 6627, email [roger\\_scott\\_ocnzl@ibm.net](mailto:roger_scott_ocnzl@ibm.net). ♦



## High voltage DAQ adaptor

IOtech has released the WBK61 single channel high-voltage adaptor, a new option for its WaveBook/512 data acquisition system which is claimed to be the only PC-based, 1MHz portable, multi-channel digitiser currently available. The adaptor connects to the WaveBook/512 or its WBK10 expansion module via BNC connectors and has two safety style banana jack inputs. The adaptor enables the WaveBook/512 to be used in applications requiring voltage measurement up to 1000Vp. The unit includes cables with probe tops and alligator clips. By using multiple adaptors, it's also possible to capture three-phase voltage waveforms.



Also available is Waveview, one of IOtech's graphical set-up data acquisition and display software packages, said to allow users to configure a system, display and stream data to disk within moments of connecting the hardware. The spreadsheet-style software features point-and-click, and application parameters can be set without the need to write code.

For further information circle 165 on the reader service coupon or contact Scientific Devices Australia, PO Box 163, Oakleigh MDC 3166; phone (03) 9569 1366.

## Software for industrial automation

National Instruments has announced BridgeVIEW, a new graphical software package for building 'industrial strength' automation systems for a wide variety of process and discrete manufacturing applications. The program is based on the company's LabVIEW graphical software for virtual instrumentation, and provides real-time process monitoring, historical trending, on-line configuration and programmable logic controller (PLC) connectivity.

It features an intuitive graphical user



interface combined with a graphical software development language called 'G', which can perform data acquisition and analysis, address unique and sophisticated man-machine interface (MMI) applications, and be used to develop supervisory control applications. The program is suited to a wide variety of industrial applications including R&D, supervisory control and data acquisition (SCADA), product testing and environmental monitoring.

For further information circle 166 on the reader service coupon or contact National Instruments Australia, PO Box 466, Ringwood 3134; phone (03) 9879 5166. (Website at <http://www.natinst.com/>)

## GPS REFERENCED INTELLIGENT TIME & FREQUENCY STANDARDS & CLOCKS



### THE DINDIMA GROUP PROPRIETARY LIMITED

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Email: [dindima@ozemail.com.au](mailto:dindima@ozemail.com.au)



The instruments generate a time scale using a precision-oven quartz oscillator or a very high precision rubidium oscillator which is periodically locked to co-ordinated universal time (UTC) by GPS satellite-derived signals. Frequency offsets due to temperature and ageing effects are automatically corrected against GPS-derived signals. Intelligent profiling optimises corrections and minimises short term as well as long term drift.

Pictured are:

1. MRS330 Modular T&F System with rubidium main and OCXO secondary oscillators, with auto change over, battery back-up, fault monitoring and signalling, module hot swap capability, etc., for demanding military and civil applications.
2. GFTS550 rubidium oscillator based T&F Standard.
3. The versatile, modest cost GFTS500 OCXO T&F standard.



## High end workstations

Compaq Computer has released a new range of professional quality workstations, claimed to outperform more expensive proprietary RISC/UNIX systems. Billed as the company's first technical workstation family, Compaq also says the systems feature high-end graphics, superior management and integration tools, and high performance networking tools for operation in small workgroups, or as part of a large system.

Software and hardware vendors supporting the new workstations include Microsoft and Intel; software suppliers that cover mechanical computer aided design (MCAD), financial applications and interactive content development; and hardware vendors of professional 3D graphics subsystems.

Compaq has also entered into an agreement with Hummingbird, a supplier of PC-to-mainframe communication services and PC-to-UNIX connectivity software. Hummingbird applications include the ability to display UNIX-based graphics running across a network, claimed to eliminate the need for a UNIX-based secondary workstation.

All models in the range come with one or two 200MHz Pentium Pro processors and Windows NT Workstation 4.0 (3.51 is also available). Features include a Wide-Ultra SCSI controller, up to 512MB of ECC DIMM memory, 8X CD-ROM drives, and an integrated NetFlex-3 auto sensing network interface card for connection to a traditional 10Mb/s or high speed 100Mb/s Ethernet LAN.

The workstations are suitable for applications ranging from financial and entry-level 2D CAD, to those needing



3D graphics. Prices for the 2D graphics-oriented systems range from \$8337 to \$10,413 and 3D systems have an RRP ranging from \$15,578 to \$19,541.

For further information circle 163 on the reader service coupon or contact Compaq Computer Australia, PO Box 1220, Lane Cove, 2066; phone (02) 9911 1999.

## Frame grabber with text & graphic overlay

MuTech has introduced the new Image/VGA-400 PCI bus integrated frame grabber and display controller, claimed to be the first low cost PCI bus frame grabber that allows the user to overlay text and graphics non-destructively on top of a live video display.

The card is a single slot half-size PCI board with an integrated VGA accelerator chip and display controller. It has three NTSC/PAL inputs and one S-VHS (Y/C) video input, which are software selectable. Video images can be digi-

tised and displayed in real time in a resizable window on a VGA monitor. Text and graphics can be written into the VGA portion of the memory. Chroma key underlay of a background is also supported.

For further information circle 161 on the reader service coupon or contact The Dindima Group, PO Box 106, Vermont 3133; phone (03) 9873 4455.

## Satellite tracking software

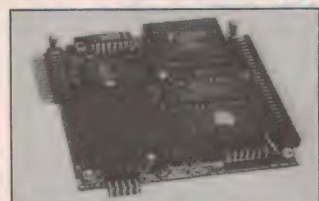
The Micro Orbiter 3.0 from International Radio Monitors (IRM) is a satellite tracking program for a personal computer. Using high resolution graphics and inbuilt algorithms, the program is said to be able to display and track the precise orbital position of any Earth-orbiting satellite. It also computes detailed visible and line-of-sight pass data for any point on the globe.

Ten world map projections are provided, which can be used in a variety of sizes and styles. Up to 20 satellites can be tracked simultaneously. For amateur radio users, Doppler shift and antenna pointing angles are also computed. The program provides context-sensitive help, and allows colours and other user preferences to be set.

Micro Orbiter 3.0 is suitable for amateur radio operators, weather satellite tracking enthusiasts, university and technical college students, as well as professionals. Included in the package is an 82-page user manual, a reference card and technical help via phone or email.

For further information circle 167 on the reader service coupon or contact International Radio Monitors, PO Box 167, Canterbury 3126; phone (03) 9857 5512, email [irma@tbsa.com.au](mailto:irma@tbsa.com.au).

## Australian Computers & Peripherals from JED... Call for data sheets.



### Australia's own PC/104 computers.

The photo to the left shows the JED PC540 single board computer for embedded scientific and industrial applications. This 3.6" by 3.8" board uses Intel's 80C188EB processor. A second board, the PC541 has

a V51 processor for full XT PC compatibility, with F/Disk, IDE & LPT. Each board has two serial ports (one RS485), a Xilinx gate array with lots of digital I/O, RTC, EEPROM. Program them with the \$179 Pacific C. Both support ROMDOS in FLASH. They cost \$350 to \$450 each.

**JED Microprocessors Pty. Ltd**

Office 7, 5/7 Chandler Road, Boronia, Vic., 3155. Phone: (03)9 762 3588 Fax: (03)9 762 5499

**\$125 PROM Eraser, complete with timer**

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SEE OUR DATA SHEETS AT [www.jedmicro.com.au](http://www.jedmicro.com.au)



(Sales tax exempt prices)



## Rugged notebook meets mil specs

FieldWorks has added the FW5000 notebook to its range of ruggedised, mil-spec mobile field computers. It measures 31.4 x 32.7 x 9.52cm, weighs 4.54kg, and suits harsh environment field applications including those encountered by police and defence forces.

The modular design of the notebook is claimed to allow easy upgrades and custom configuration. Four side-opening expansion bays house a combination of modules including hard drives (up to two 1.3GB drives), CD-ROM drives (up to two), floppy drives, AC power in, batteries (up to two, with a three-hour minimum per battery), up to two PCMCIA modules (for a total of four PCMCIA slots) and future options. All modules can be installed and positioned by the user. The CPU and critical electronics are located on a 'technology module' in the rear of the notebook.

The computer has a one-piece chassis made of a rigid, lightweight magnesium alloy. Energy absorbing rubber is moulded to the chassis to protect internal subsystems from shock and vibration, allowing it to withstand up to 100G operating shocks. (A G is the force of gravity, and a force of



10G renders an aircraft pilot unconscious.) It can also handle temperature, humidity extremes and dust, and is internally cooled so no outside air can enter. An optional package provides environmental and electromagnetic interference protection.

For further information circle 162 on the reader service coupon or contact Racal Australia, 3 Powells Road, Brookvale 2100; phone (02) 9936 7000.

## Low cost colour scanner

Hewlett-Packard has released the HP ScanJet 5p scanner, a 24-bit colour/8-bit greyscale desktop flatbed scanner which replaces the HP ScanJet 4p scanner and has an RRP of \$599 including sales tax.

The new scanner features a pushbutton

front panel to automatically start the scanning process. It is claimed to be one of the industry's first flatbed scanners to receive Windows 95 certification from Microsoft. The new scanner is about 40% smaller than the 4p scanner and features recessed SCSI and power cables so it can be placed directly against a wall.

The scanner has an optical resolution of 300 dots per inch (1200dpi enhanced) and handles documents up to 216mm by 297mm (A4 size), including some three-dimensional and bound materials. It has energy saving features and is available for PC-compatible and Macintosh computers.

Included with the scanner is a CD-ROM containing an on-line tutorial and bundled scanning software, including HP PictureScan 3.0, which automatically scans images into documents. This software includes an enhanced user interface which gives additional control over scanning settings, and includes HP AccuPage optical character recognition (OCR). Also included is the HP ScanJet copy utility, which enables the scanner to be used as a photocopier in conjunction with a colour or black and white printer.

For further information phone the HP Customer Information Centre on 131347. Information about HP products is on the World Web at <http://www.hp.com>. ♦

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## KEY TO CODING

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Based on a high quality Japanese thick film alcohol sensor. Kit includes PCB, all on board components and a meter movement: **\$30**

**GEIGER COUNTER KIT**

Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all on board components, a Money Detector (see above), speaker and YES, the Geiger tube is included: **\$30**

**IR TESTER**

Includes a blemished IR converter tube as in night vision and an EHT power supply kit, excellent for seeing IR sources, much more sensitive than expensive IR sensitive cards, price depends on blemishes: **\$30-\$40**

**RARE EARTH MAGNETS**

Very strong! 7x3mm \$2, 10x3mm \$4, Toroidal 50mm outer, 35mm inner, 5mm thick: **\$10**

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Square, 85 x 85mm, 4-40kHz, 35V RMS: **\$8**. Wide dispersion, 67 x 143mm, 3-30kHz, 35V RMS: **\$9**

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Standard large supply as used in large computer towers, +5V/22A, +12V/8.5A, -5V/0.5A, -12V/0.5A, used, ex cond, guaranteed: **\$30**

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Small jewellers eyepiece: **\$3**, 30mm loupe: **\$8**, 75mm loupe: **\$12**, 110mm loupe: **\$15**. Set of one each of these magnifiers (4): **\$30**

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Small complete unit with cold cathode UV tube, works from two AA batteries (not supplied). Inverter can dimly light a 4W fluoro tube: **\$5 ea or 5 for \$19**

**12V - 2.5W SOLAR PANEL KIT**

US amorphous glass solar panels 305 x 228mm, Voc 18-20V, Isc 250mA: **\$22 ea, 4 for \$70**

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Tiny (38x38x27mm) CCD camera, 0.1 lux, IR responsive (works in total dark with IR illumination). Connects to any standard video input or via a modulator to aerial input: **\$125**.

**Bonus:** With each camera you can buy the following at reduced prices:

- Commercial UHF video/audio transmitter for **\$15** (normally \$25)
- IR illuminator kit with 42 880nm LEDs **\$25** (normally \$35)
- Regulated 10.4V plugpack for **\$10** (normally \$25)

**CAMERA - TIME LAPSE VCR RECORDING SYSTEM**

Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **\$90**

**ARGON-ION HEADS**

Used Argon-ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. Power supply circuit provided. Size: 35x16x16cm, weight 6kg. Needs a 1kW transformer, available elsewhere for about \$170. Argon head only: **\$350**

**DIGITAL RECORDING MODULES**

Small voice recording modules as used in greeting cards. Powered by watch batteries (included). Also includes a suitable mini electret microphone. 6 second module: **\$9**

**LOW COST IR ILLUMINATOR KIT**

Allows a CCD camera or a night viewer to work in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs (not relatively useless 940nm): **\$35**

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Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **\$18**

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Unusual lens assemblies from industrial equipment: **3 for \$22**

**MIDI KEYBOARD**

Quality MIDI keyboard with 49 keys, 2-digit LED display, MIDI out jack. Size: 655 x 115 x 35mm. Computer software included, see review EA Feb. 97: **\$80** 9V DC plugpack: **\$10**

Larger model also available with more features & touch sensitive keys: **\$200**

**STEREO FM TRANSMITTER KIT**

88 - 108MHz, supply 6-12V, current 8mA (@ 9V), PCB size 25 x 65mm. Kit includes PCB and all on-board components, 9V battery connector, and 2 electret microphones: **\$25**

Plastic case to suit: **\$4**

**WOOFER STOPPER**

Works on dogs and most animals, ref SC Feb 96. Includes PCB and all on board components, transformer, electret mic & horn piezo tweeter: **\$39**, extra tweeters (drives 4): **\$6 ea**

**IEC LEADS**

Used Australian IEC leads: **\$2.50**

**CENTRAL LOCKING KIT**

A complete central locking kit for any vehicle. Good quality, with Mabuchi motor actuators. Can be controlled from existing UHF remote controls. Kit includes 4 actuators, control box, wiring harness, screws-nuts, other mechanical parts: **\$60**. Actuators are available separately: **\$9 ea**

**CODE HOPPING UHF CENTRAL LOCKING KIT with UHF REMOTE**

Uses code hopping encoder and decoder ICs for ultimate security. Similar to the above system, but has built-in UHF receiver. Includes two matching 2-button UHF transmitters. One button locks, the other unlocks. Receiver has 3 relays: two for central locking and one that's activated in the lock position — for immobiliser etc. Kit also includes 4 actuators, control box, wiring harness etc: **\$109**

**ELECTROCARDIOGRAM PCB+DISK**

The software disk and a silk screened and solder masked PCB (PCB size: 105 x 53mm) for the ECG kit published in EA July 95. No further components supplied: **\$10**

**SECURE IR SWITCH**

Allows toggle switching of a relay from an IR transmitter. Both Tx & Rx can be coded so more than can be used in the same area. Includes commercial 1 button transmitter, receiver PCB and parts to operate a relay (not supplied): **\$22**

**FLUORESCENT TAPE**

High quality Mitsubishi all weather 50mm wide red reflective tape with self adhesive backing: 3m for **\$5**

**IR LASER DIODE KIT**

Kit of basic items for experimenting with 780nm/5mW laser diodes. Has new SHARP infrared laser diode (just visible), adjustable combined collimator lens and heatsink, constant current driver kit (K34) and an infrared PIN diode for a detector, plus basic instructions. Laser diode is suitable for medical use, perimeter protection, data transmission, spot IR illumination, etc: **\$32**

**WIRELESS IR EXTENDER**

Converts the output of any IR remote control unit to a UHF transmission. Transmitter is self-contained (includes battery), attaches with Velcro strap under IR transmitter. Receiver has 2 IR LEDs, and is placed near appliance being controlled. Kit includes two PCBs, all components, 2 plastic boxes, Velcro strap: **\$35**. (9V battery for transmitter not included.) Suitable plugpack: **\$10**.

**NEW - LOW COST 2 CHANNEL UHF REMOTE CONTROL**

New 2 channel security encoded UHF remote control has a small keyring style pre-assembled transmitter (includes 12V battery), receiver has 5A relay contact output, can be arranged for toggle or momentary operation, receiver has pre-assembled front-end UHF receiver module: **\$35** for one transmitter and one receiver, additional transmitters: **\$12 extra**

# OATLEY ELECTRONICS

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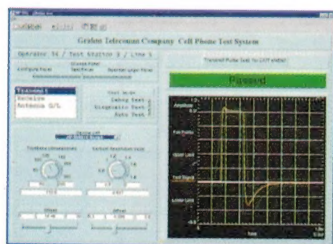
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